EXECUTIVE SUMMARY

ENERGY ENGINEERING ANALYSIS

of

SIERRA ARMY DEPOT

for

U.S. ARMY COPRS of ENGINEERS
SACRAMENTO DISTRICT

April, 1984

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LIST OF ABBREVIATIONS

BFW	Boiler Feed Water
Btu	British Thermal Unit
CEC	California Energy Commission
CY	Cubic Yard
DHW	Domestic Hot Water
DOE	Department of Energy
ECM	Energy Conservation Measure
ECO	Energy Conservation Opportunity
EUI	Energy Usage Index (KBtu/ft^2)
FC	Foot Candle
-HP	-Horsepower
HVAC	Heating, Ventilating & Air Conditioning
HX	Heat Exchanger
KBtu/ft^2	Thousands of Btu's per square foot
KV	Kilovolt
KVA	Kilovolt ampere
KW	Kilowatt
KWH	Kilowatt Hour
LF	Linear Foot
MB	Mega Btu
MW	Megawatt
MWH	Megawatt Hour
PPH	Pounds per Hour
SF	Square foot
SIR	Savings Investment Ration
SY	Square Yard
UA	Heat Loss Factor (Btu/hr °F)
ΔUA	Change in Heat Loss Factor (Btu/hr °F)

CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF PROJECT

Reference

The purpose of the Energy Engineering Analysis Program (EEAP) is to provide a Basewide Energy Plan in compliance with the objectives of the Army Facilities Energy Plan (AFEP). The Basewide Energy Study provides a coordinated plan to reduce energy consumption in keeping with the long term objective of becoming as energy self-sufficient as feasible without sacrificing the mission of the Post.

Vol. 1
Sec. 1.2

1.2 STUDY INCREMENTS

The Basewide Energy Plan was developed from the energy recommendations of seven different increments of work as defined by the EEAP and summarized below (full scope included in Appendix Vol. 1):

Vol. 1
Sec. 1.2

Increment A: Buildings

ECIP projects involving buildings and their contents.

Increment B: Utility Systems & EMCS

ECIP projects involving utility distribution systems, and feasibility of an Energy Monitoring and Control System (EMCS).

Increment C: Renewable Energy

Feasibility of converting energy consuming systems to solar, biomass, hydroelectric, wind, or geothermal energy.

1.2 STUDY INCREMENTS (cont'd) — Reference

Increment D: Cogeneration & Solid Waste

Feasibility of installing cogeneration and solid waste, refuse derived fuel (RDF) or waste oil heating plant.

Increment E: Boiler Plants

Feasibility study of centralizing boiler plants or converting existing plants to solid fuel.

Increment F: O&M/Minor Construction

O&M Projects and Increment A and B projects which meet all ECIP criteria except project cost ($200,000 or over) and which are within the funding authority of the Facilities Engineer.

Increment G: ECIP Drop-Outs

Projects from Increment A and B which fail to meet ECIP criteria.

1.3 STUDY ORGANIZATION

The detailed analysis, conclusions and recommendations of the Basewide Energy Plan are organized into the following volumes: (Vol. 1 Sec. 1.1)

	Executive Summary
Volume 1	Increments A, B, C, D, E, G Text and Appendix
Volume 2	Programming Documents
Volume 3	Increment F and Appendix
Volume 4	Building Data Sheets

CHAPTER 2

EXISTING ENERGY CONSUMPTION

		Reference
2.1	DESCRIPTION OF POST	

2.1.1 Location

Sierra Army Depot (SIAD) is an ammunition depot, located at Herlong, California, in the high desert area east of the Sierra Mountains, approximately 55 miles northwest of Reno, Nevada and 40 miles southeast of Susanville, California. It is relatively flat land ranging in elevation from about 4,100 to 4,200 feet above mean sea level. The depot consists of 36,313 acres bordering the south edge of Honey Lake which is a large, shallow (maximum depth 10 feet), highly alkaline lake.

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2.1.2 Climate

Being in the high western desert, SIAD experiences large swings in daily temperatures (40°F range in summer) and low relative humidity (less than 20% in summer). The summer design temperature is 96°F and the winter design temperature is 6°F.

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Prevailing winds are from the north/northwest at mean velocity of 5 miles per hour. The mean wind values are misleading in that wind normally occurs in the afternoon period from 1PM-7PM and is relatively calm the remaining hours of the day.

The average annual precipitation (for Susanville) is 14.5 inches of which approximately 6" comes from the 56" of annual snowfall.

Of the 178 heated buildings at SIAD, this study includes detailed analyses of 85 buildings which are typical of another 78 buildings. The 15 buildings not surveyed are small and/or seldom used and account for less than 3.8% of SIAD's energy usage. — Reference

2.1.3 Mission

The mission of SIAD is the receipt, storage, renovation and shipment of conventional weapons, special weapons, and general ammunition supplies. — Vol. 1 Sec. 3.1.2

2.1.4 Number & Size of Buildings

SIAD has 1,181 buildings with a total floor area of 5,177,070 sq. ft. Only 178 buildings are heated. The remaining 1,003 buildings are unheated storage areas, i.e. igloos. The buildings fall into heated and unheated, permanent and temporary categories as follows: — Vol. 1 Sec. 3.1.3

TABLE 2.1

NUMBER & SIZE OF BUILDINGS

	Permanent		Temporary		Totals	
	No.	SF	No.	SF	No.	SF
Heated	68	391,759	110	400,615	178	792,374
Unheated portion of heated bldgs.	-	15,859	-	2,150,175	-	2,166,034
Unheated	966	2,019,327	37	199,335	1003	2,218,662
Total	1034	2,426,945	147	2,750,125	1181	5,177,070

2.2 EXISTING ENERGY SYSTEMS

Reference

2.2.1 Energy Sources & Costs

SIAD uses energy in 4 different forms: electricity, #2 fuel oil, propane, and coal. Following are the sources of each and their cost as of Aug '82. — Vol. 1 Sec. 3.2

TABLE 2.2

ENERGY SUPPLIERS & COSTS

Energy	Supplier	Cost	$/MB
Electricity	C.P. National Concord, CA	$0.07759/KWH (6AM-10:30PM) $0.07659/KWH (10:30PM-6AM) $3.97/KW demand	22.73 22.41
Fuel Oil	Industrial Fuels Milwaukee, Wis	$1.37/Gal	9.79
Propane	Richins Propane Susanville, CA	$0.65/Gal	6.80
Coal	United States Fuel Co. Salt Lake City, Utah	$49.44/Ton	2.00

2.2.2 Electrical Distribution

34.5 KV power, purchased from C.P. National, enters the post at the northwest corner through a government owned 400 amp air switch and metering station. Distribution voltage is dropped to 4160 volts at 3 substations. — Vol. 1 Sec. 3.3.1

2 substations owned by the government serve the Magazine, Cantonment and Supply areas. The third substation, owned by C.P. National serves the Wherry Housing area. Power through the Wherry Housing substation is metered and subtracted from the main meter to arrive at SIAD's consumption.

2.2.3 Central Steam Distribution

Reference

4 fuel oil or coal-fired boiler plants generate 50-90 psig steam which is distributed in approximately 15,000 LF of direct-buried steam and condensate piping to three separate areas on Post: Cantonment, Supply, and the Bldg. 599 area. The steam systems serve 29 of the 178 heated buildings. 3 boiler plants have been abandoned. Following is a list of the plants.

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TABLE 2.3

LIST OF CENTRAL BOILER PLANTS

BOILERS

Boiler Plant No.	Bldg No.	Area of Post	Size (HP)	Fuel	Med. Ht'd.	Avg Effic %	Gen'l Cond'n	Bldgs Served
1	54	Cantonment	3-250 Firetube	Oil	Stm	86.3	Good	2,52,53,54, 55,59,60,61, 63,64,68,74, 75,76,150, 165-168
2	202	Supply	2-250 1-125 Firetube	Oil	Stm	85.3	Good	201,02,05.06, 07,08,09,10
3	402	Ammo Renovation	2-250	Oil	Stm	N/A		Abandoned
4	76	Cantonment	2-128	Coal	Stm	N/A	Poor	Conn. to same system as BP 1 & 6
5	407	Ammo Shipping		Oil	Stm	N/A		Abandoned
6	163	Cantonment	2-128	Coal	Stm	N/A	Poor	Abandoned-Conn. to same system as BP 1 & 4
7	598	599 Area	2-150 Water Tube	Oil	Stm	77.2	Good	597 & 599

2.2.4 Individual Boilers & Furnaces

149 buildings at SIAD use individual boilers or furnaces including 68 residences. Of these, 41 are oil fired, 113 are propane and 3 are coal. 5 boilers are steam and the remainder are hot water. Sizes and capacities (when obtainable) are listed in the building descriptions contained in Volume 4, Building Data Sheets. Table 2.4 lists all buildings in the scope and gives a brief description of their heating systems.

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TABLE 2.4

SUMMARY OF BUILDING HEATING SYSTEMS & OCCUPANCY CODES

Occup.* Code	Bldg. No.	Building Name	Fuel	Htg. Source	Htg. Medium	Type Htg. System
B	1	Headquarters	O	Indiv. Boiler	Steam	Rad'rs & Conv. Htrs
E	2	Fire Station	S/O	B.P/Indiv. Boiler	H.W.	Rad'rs, Conv. Htrs S.P. Htrs
B	7	Career Coun/Rec.Ctr	O	Indiv. Furnace	Air	H.V. Units
E	21-25	Family Housing	O P(B/25)	Indiv. Furnace	Air	H.V. Unit
E	26	V.O.Q./Comm.Club Annex	O	Indiv. Boiler	H.W.	Conv. Htrs
E	27	B.O.Q.	O	Indiv. Furnace	Air	H.V. Unit
E	28-30	Family Housing	P	Indiv. Boiler	H.W.	Conv. Htrs
E	51	Communication Center	P	Indiv. Boiler	H.W.	H.V.
A	52-53	Operation & Equip. Maint.	S	B.P. 1 or 4	Steam	Conv.Htrs & SP. Htrs
	54	Boiler Plant 1				
A	55	Motor Repair Shop	S	B.P. 1 or 4	Steam	SP. Htrs
B	58	Gen.Storage/Elect.Rep (Office only htd)	S	Indlv. Htrs	Air	SP Htrs
B	59	Gen. Storage (Off.only htd)	S	B.P. 1 or 4	Steam	Rad'rs
C	60	Commissary	S	B.P. 1 or 4	Steam	H.V. Unit & SP Htrs
A	61	R.R. Equip. Maint.	S	B.P. 1 or 4	Steam	Conv. Htrs & SP Htrs
B	63	Property Account Ability	S	B.P. 1 or 4	Steam	Rad'rs
Z	64	Stand By Ready Room	S	B.P. 1 or 4	Steam	SP Htrs & Conv Htrs
	68	Flamable Storage	S	B.P. 1 or 4	Steam	SP Htr
A	74	Supply Ctr/Maint Shop	S	B.P. 1or 4	Steam	SP Htr
B	75	Eng.Admin. Building	S	B.P. 1 or 4	H.W.	Rad'rs & Conv. Htrs

TABLE 2.4 (cont'd)

Occup.* Code	Bldg. No.	Building Name	Fuel	Htg. Source	Htg. Medium	Type Htg. System
	76	Boiler Plant # 4				
B	79	Maint. Shop (50% Htd)	O	Indiv. Boiler	H.W.	Rad'rs & SP Htrs
F	81	Water Well	E	Indiv. Htr	Air	SP Htr
B	84	Civ. Personnel Bldg.	O	Indiv. Boiler	H.W.	Conv. Htrs
F	89	Chlorinator Bldg.	E	Indiv. Htr	Air	SP Htr (not functioning)
F	91	Booster Pump House	E	Indiv. Htr	Air	SP Htr
F	92	Pump Control House				No Htrs
F	124	Outdoor Swim.Pool	O	Indiv. Boiler	H.W.	Pool Heater
F	128	Water Well	E			
Z	135	Ready Bldg.	P			
F	141	Water Well	E	Indiv. Htr	Air	SP Htr
G	150	Hospital Clinic	S	B.P. 1 or 4	Steam	H.V.
	163	Boiler Plant #6 (no longer used)	C			
E	165	Admin.Support Bldg./ Mess Hall	S	B.P. 1 or 4	H.W.	H.V. Units
E	166-168	B.E.Q.	S	B.P. 1	H.W.	H.V. Units
	170	Chapel	O	Indiv. Boiler	H.W.	H.V. Units
E	176-195	Family Housing	P	Indiv. Furnace	Air	H.V. Unit
	201	Sup.Serv.Admin.Bldg.	S	B.P. 2	H.W.	Rad'rs & Conv. Htrs
	202	Boiler Plant #2	O			
B	203	Bomb Disposal	O	Indiv. Furnace	Air	H.V. Unit
A	206	Paint Shop	S	B.P. 2	Steam	H.V. Unit
A	207	Box Bldg.	S	B.P. 2	Steam	H.V. Unit
A	208	Operation Bldg.	S	B.P. 2	Steam	SP Htrs
A	209	Air Craft Operations	S	B.P. 2	Steam	SP Htrs & Conv. Htrs

TABLE 2.4 (cont'd)

Occup.* Code	Bldg. No.	Building Name	Fuel	Htg. Source	Htg. Medium	Type Htg. System
A	210	Operations Bldg.	S	B.P.	Steam	SP Htrs
B	301-311	Gen. Purpose Warehouse (small office only heated)	P	Indiv. Htrs	Air	SP Htrs
B	316	Property Disposal	P	Indiv. Htrs	Air	SP Htrs
B	317	Receiving	P	Indiv. Htrs	Air	SP Htrs
Z	351-364	Gen Purpose Warehouse (small office only heated)	P	Indiv. Htrs	Air	SP Htrs
B	400	Magazine Field Office	O	Indiv. Boiler	H.W.	Rad'rs
B	401	Ammo. Inspect. Workshop	O	Indiv. Boiler	Steam	SP Htrs
A	403	Ammo. Workshop	O	Indiv. Boiler	H.W.	SP Htrs
	437	Ops. Gen. Purpose		-----	not occupied	-----
	489	OPS. Gen. Purpose	E	Typical of 437		
	509	OPS. Gen. Purpose	E	Typical of 437		
	528	OPS. Gen. Purpose	E	Typical of 437		
	533	OPS. Gen. Purpose	E	Typical of 437		
	541	Inspection Bldg.	O	Indiv. Boiler	H.W.	H.V. Units
	543	OPS Gen. Purpose	P			
B	544	Shipment Bldg.	O	Indiv. Boiler	H.W.	Conv. Htr & SP Htrs
A	556	Pop Shop	E	Indiv. Htr	Air	Conv. Htr
B	564	Change House	O	Indiv. Boiler	Steam	Rad'rs
A	593	Ammo. Renv. Shop	O	Indiv. Boiler	H.W.	H.V. Unit & Conv. Htrs
B	597	Adm. Gen. Purpose	S	B.P. #7	H.W.	Conv. Htrs
	598	Boiler Plant #7	O			
Z	627	Airfield Radio Equip. Fac.	P	Indiv. Htrs	Air	SP Htrs
B	634	Lunch Rm/Lockers	O	Indiv. Boiler	H.W.	H.V. Unit
A	640	Ammo. Maint	O	Indiv. Boiler	H.W.	H.V. Units & Radiant Floor
A	641	Ammo. Renv. Shop	O			

TABLE 2.4 (cont'd)

Occup.* Code	Bldg. No.	Building Name	Fuel	Htg. Source	Htg. Medium	Type Htg. System
B	1010	980th Mil. Police Bldg.	O	Indiv. Boiler	H.W.	Conv. Htrs & SP Htrs
C	1019	Bowling Center	O	Indiv. Boiler	H.W.	Conv. Htrs
E	1101-1120	Family Housing	P	Indiv. Furnace	Air	H.V. Unit
E	1201, 03, 14	E.M. Barracks w/o Mess	O P(1203)	Indiv. Boiler	H.W.	Rad'rs
E	1202, 4, 8	E.M. Barracks w/o Mess	C	Indiv. Boiler	H.W.	Rad'rs
B	1217	Enlisted Person Mess	O	Indiv. Boiler	Steam	Conv. Htrs & SP Htr
E	1218	Community Club	S & P	B.P. Bldg. 1217	Steam	Conv. Htrs
B	1223	Mil. Personnel Office	O	Indiv. Furnace	Air	H.V. Unit
D	2067	Community Center	O	Indiv. Furnace	Air	H.V. Units
D	2068	Community Center	O	Indiv. Furnace	Air	H.V. Units
D	2069	Post Exchange/Credit Union/Family Market	O	Indiv. Boiler & Indiv. Htrs	H.W. & Air	Conv. Htrs & SP Htrs
B	2071	Theatre	C	Indiv. Boiler	H.W.	Conv. Htrs

Occup. Code

Code	Hr/d	d/wk	Winter Design	Sample Bldg.
A	10	5	60°	208
B	10	5	68°	79
C	10	6	68°	
D	11	7	68°	2067 (10A-9P)
E	24	7	68°	28 & 166
F	24	7	45°	
G	24	7	72°	
H	10	6	70°-75°	150
Z	Intermittent			

Fuel Codes

S = Steam
O = Oil
C = Coal
P = Propane

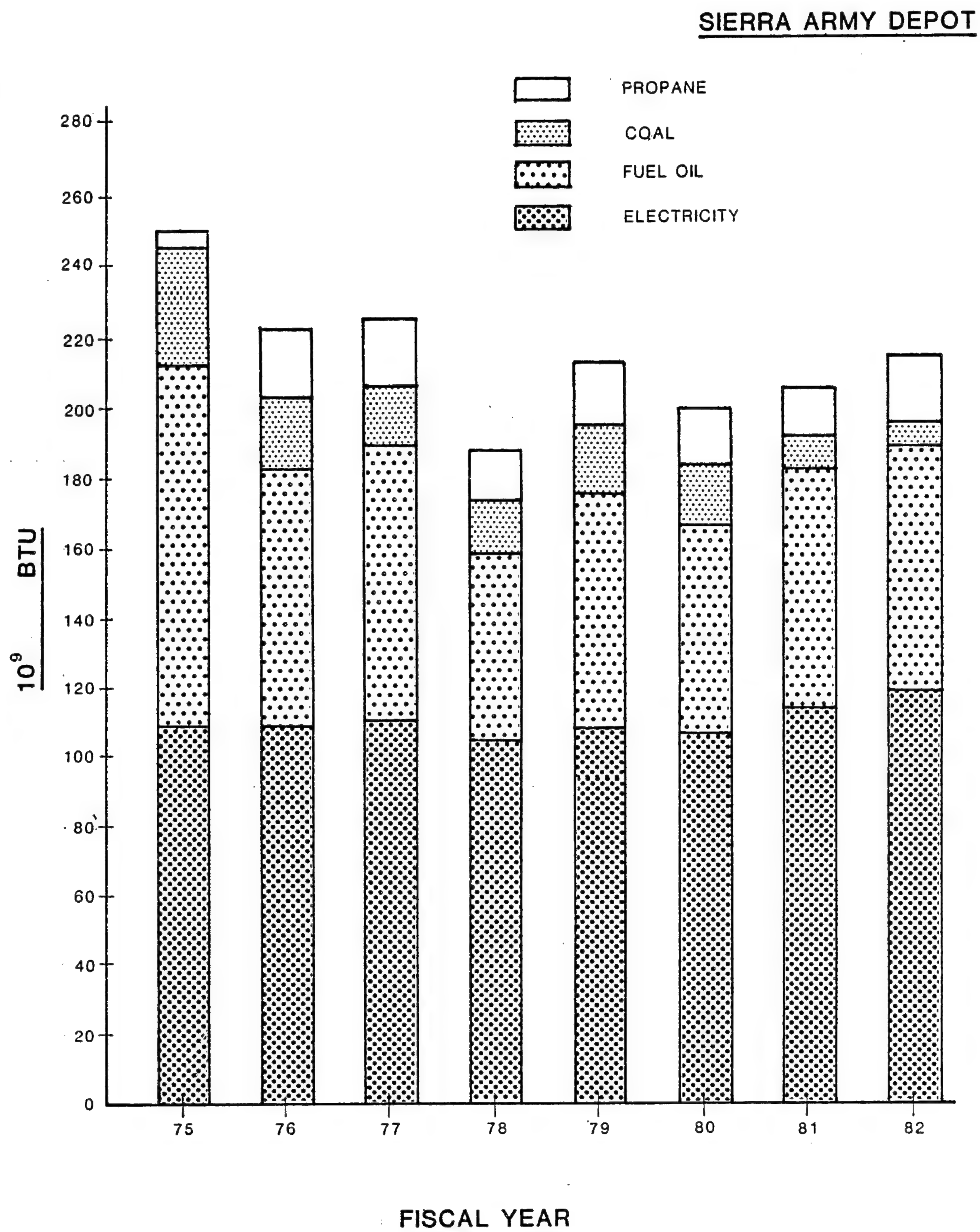
2.3 HISTORICAL ENERGY CONSUMPTION (FY 75-82) — Reference

2.3.1 Total Energy

The total facilities energy consumption (without transporation fuel) decreased 14% from FY 75 to FY 82 (see Fig. 2-1) despite a 10% increase in heated building area. Fig. 2-2 indicates that the EUI (Energy Usage Index) for heated buildings has decreased 22%, from FY 75 to FY 82. — Vol. 1 Sec. 3.6

The direct correlation between energy consumption and weather is evident when comparing degree-days to KB/sq. ft. in Fig. 2-2. The similar shapes of the curves testify to the influence of weather on fuel consumption. The divergence of the two curves indicates the reduction in energy consumption. Since the degree days were approximately the same for FY 75 and 82, these 2 years provide a good opportunity to observe the actual impact of the SIAD energy conservation program. With the effect of weather presumably cancelling each other out for the two years (presumably because actual solar insolation for the two years is not known) SIAD has truly reduced EUI by 22%.

From Fig. 2-2, population changes do not seem to influence the energy consumption. Changes in population probably did have an influence on energy consumption but the influence was negated by energy conservation measures which reduced energy consumption more than the population increased it. SIAD has decreased it's EUI by 22% despite a 12% increase in population. Had the population level remained the same it is reasonable to believe that the EUI would have decreased even more than 22%.

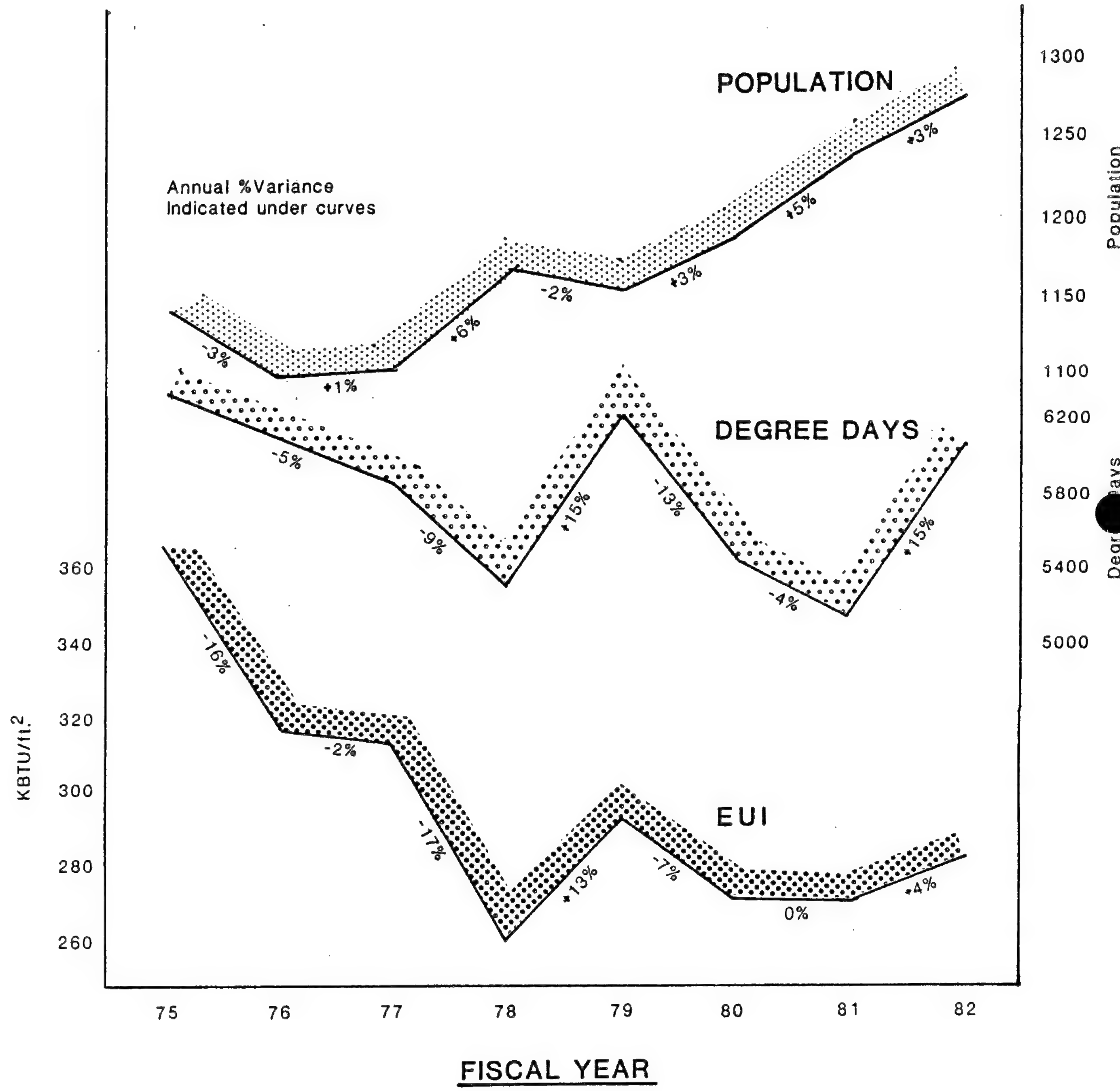


ANNUAL ENERGY CONSUMPTION

* electricity conversion 11,600 BTU/KWH

FIG. 2-1

SIERRA ARMY DEPOT



EUI vs. POPULATION & WEATHER

FIG. 2-2

2.3.2	<u>Electricity</u>	<u>Reference</u>

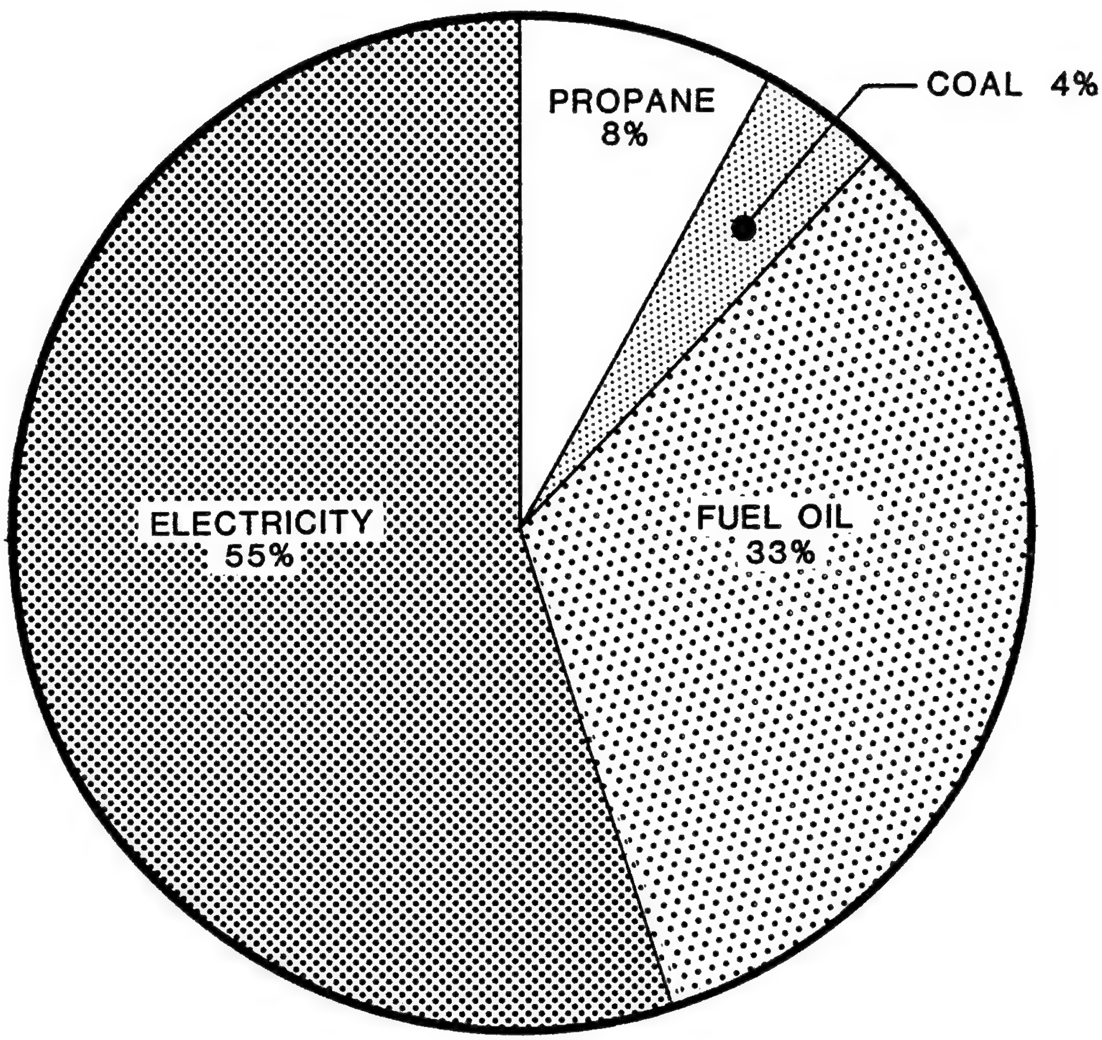
Electricity represents 55% of the total energy consumed by SIAD excluding transporation fuel (Fig. 2-3). FY 82 consumption is 8% above FY 75, however net floor area of lighted buildings has increased 10% during the same period (see Fig. 2-1). Therefore, the electrical EUI (Energy Usage Index) has actually decreased 2%. — Vol. 1 Sec. 3.6.2

The prime factor contribution to the relatively small reduction in electrical consumption was the FY 79 and 80 addition of Special Weapons Area 1 which by itself accounts for more than 11% of the total post consumption.

Monthly usage demand profiles can be seen in Fig. 2-4. Monthly usage varies 30% from winter to summer. However, peak demand varies by 50% from winter to summer. Approximately 150 KW of the summer load is due to evaporative coolers and another 200 KW due to air conditioning refrigeration.

2.3.3 <u>Fuel</u>

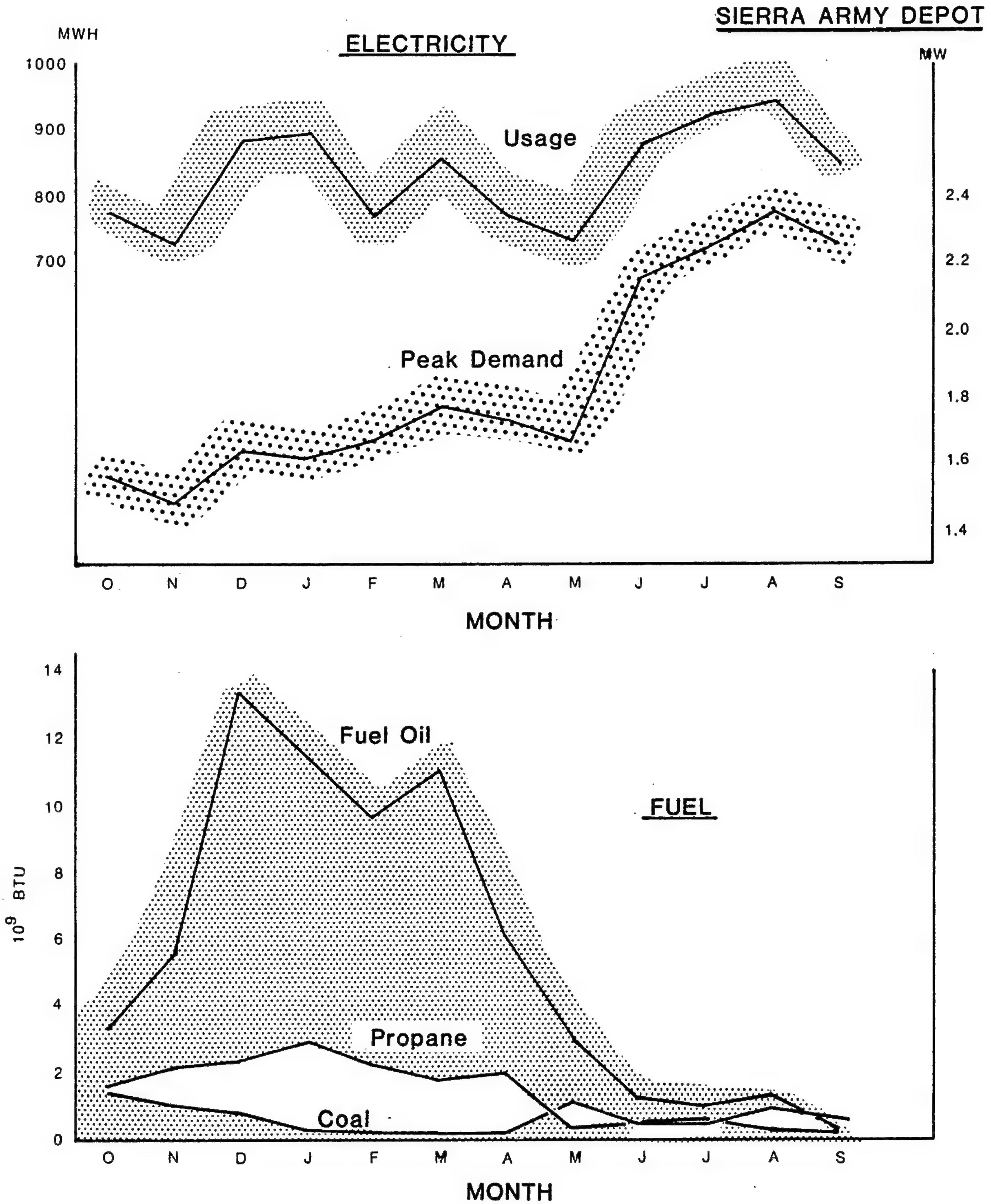
The major energy savings since FY 75 has been in fuel. Consumption decreased 32% from FY 75 to FY 82 (Fig. 2-1) despite the 10% increase in heated buildings. The fuel EUI decreased 38%. Fuel now represents 45% of the total energy consumption with fuel oil consuming 33%, propane 8%, and coal 4% (Fig. 2-3). — Vol. 1 Sec. 3.6.3



ENERGY DISTRIBUTION, FY 81

FIG. 2-3

* electricity conversion 11,600 BTU/KWH



MONTHLY ENERGY PROFILES, FY 81

FIG. 2-4

2.4	ENERGY BALANCE	Reference

2.4.1 Energy Consumption By Building Type

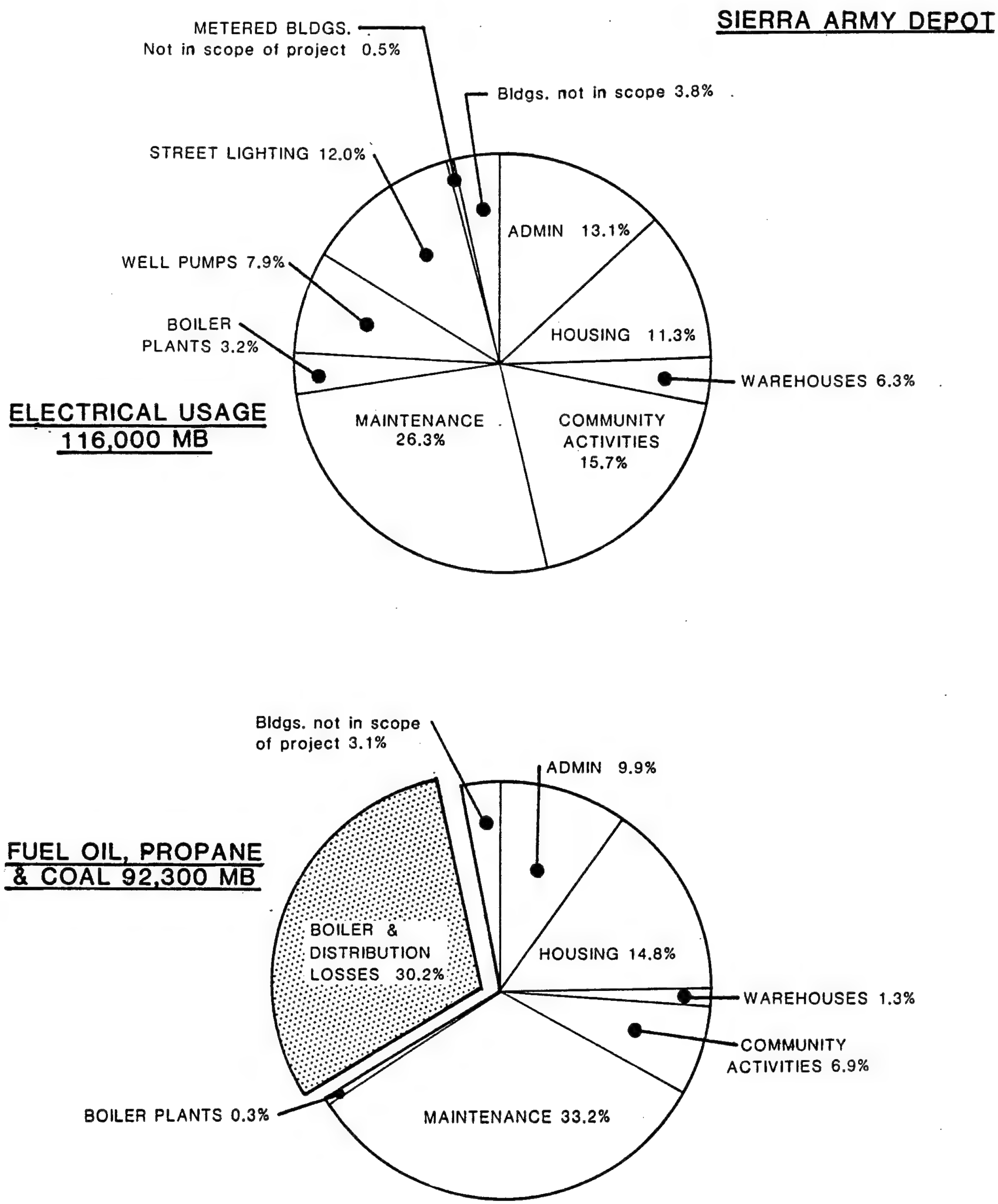
Electricity accounts for 55% of the total energy used at SIAD. Boiler plants, maintenance buildings, water wells, and warehouses consume 44%, community activities and housing 27%, administrative buildings 13% and street/area lighting 12%. (Vol. 1 Sec. 3.7.1)

Fuel oil accounts for 33% of the total enrgy used at SIAD with propane adding another 8% and coal 4%. Boiler plant and distribution losses consume 30% of the fuel used while maintenance buildings and warehouses consume 35%, community activities and housing 22%, and administrative buildings 10%.

Figure 2-5 shows the total energy consumed by the various types of buildings in FY 81. See Appendix, Vol. 1 for complete building list and designation of building type. Individual energy consumptions for each building are listed on the front page of each building description contained in the Building Data Sheets, Vol. 4.

2.4.2 Energy Consumption By System Type

Figure 2-6 indicates the total energy consumed by each general type of system at SIAD. Lists of equipment and lighting in each building are included in the Building Data Sheets, Vol 4. (Vol. 1 Sec. 3.7.2)

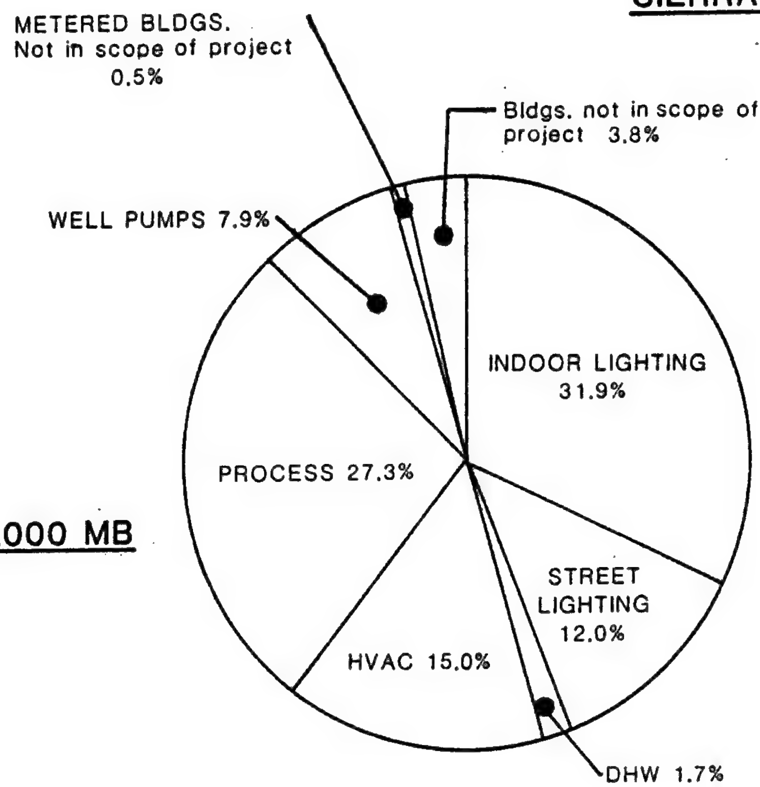


ENERGY CONSUMPTION BY BUILDING TYPE , FY 81

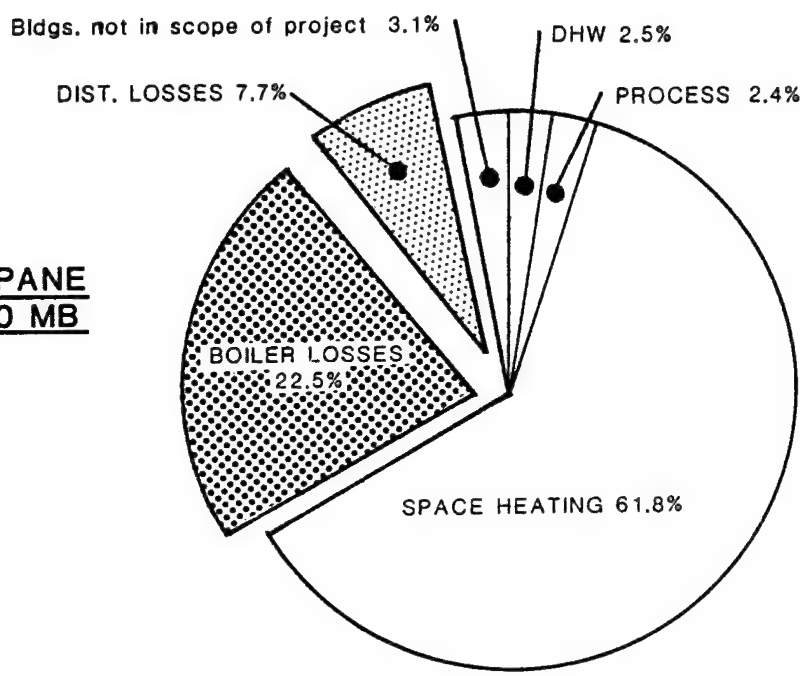
FIG. 2-5

SIERRA ARMY DEPOT

ELECTRICAL 116,000 MB



FUEL OIL, PROPANE & COAL 92,300 MB



ENERGY CONSUMPTION BY SYSTEM TYPE , FY 81

FIG. 2-6

Reference

2.5 ENERGY PROJECTS COMPLETED

SIAD has completed the following energy conservation measures since FY 75. Vol. 1 Sec. 3.8.1

1. Remove heating from portion of Bldg. 79.
2. Remove doors, close openings, and weatherstrip Bldg. 79.
3. Insulate ceiling, Bldg. 79.
4. Remove doors, close openings, and weatherstrip Bldg. 74.
5. Night and weekend setback Bldg. 74.
6. Low temperature T-stats to maintain no more than 65°F.
7. Phantom tubes.
8. Double pane windows Bldg. 1, 7, 201, 1201, 1202, 1203, 1204, 1208 and 1214.
9. Shut down Bldg. 465.
10. Insulate roofs of Bldg. 55 and 61.
11. Insulate roof and walls and weatherize all openings, Bldg. 7.
12. Delamp numerous buildings.
13. Reduce street lighting by 60 fixtures.
14. Replace condensate piping in Supply Area.
15. Replace steam line from BP 2 to main steam mainhole.
16. Outside air temperature lockouts on heating system in Bldgs. 2067, 2068 and 2069.

CHAPTER 3

ENERGY CONSERVATION MEASURES AND ADJUSTED ENERGY PROFILES

3.1 GENERAL PROCEDURE

Reference: Vol. 1, Sec. 4.1

Increments A, B, F, and G of the EEAP at Sierra Army Depot were conducted in the following general manner.

Phase 1

1. Collect previous studies and list of planned projects.
2. Review availability and accuracy of as-built drawings.
3. Collect energy accounting information.
4. Audit buildings for description of building envelope, occupancy schedules, building function and description of HVAC, DHW, lighting and processes.
5. Screen initial audit information for energy projects.

Phase 2

6. Test dynamic systems for operating parameters.
7. Calculate energy consumption of individual buildings and building systems for historical profile.
8. Computer model energy conservation measures for sample buildings.
9. Write up projects.

3.2 ENERGY CONSERVATION MEASURES IN PROGRESS

Reference: Vol. 1, Sec. 3.8.2

The following seven energy conservation projects were funded for design in FY 82.

1. Insulate roof Bldgs. 403 and 556.
2. Insulate roof Bldgs. 21 thru 25.
3. Insulate roof Bldgs. 52, 53, 55.

Reference

3.2 ENERGY CONSERVATION MEASURES IN PROGRESS (cont'd)

4. Insulate roof Bldg. 63.
5. Insulate roof Bldg. 75.
6. Insulate roof Bldg. 84.
7. Solar Heat Swimming Pool.

3.3 ENERGY CONSERVATION MEASURES RECOMMENDED

3.3.1 Increments A & B

Energy conservation measures involving buildings and utility systems whose project cost exceeds $200,000 and whose Savings to Investment Ratio (SIR) are greater than 1.0 are recommended for Energy Conservation Investment Program (ECIP) funding. Vol. 1 Sec. 4.2.1

Table 3.1 lists Increment A and B project recommendations. The projects are prioritized by SIR and indicate the project cost, annual energy and cost savings, payback and SIR.

3.3.2 Impact of Increment A and B Projects

The ECIP projects recommended in Increment A and B will reduce SIAD's energy consumption by 17.5%. An investment of $974,383 will repay itself in 2.8 years. These projects were developed for funding in FY 1986.

Table 3.2 summarizes the impact of Increment A and B projects on the total energy consumption.

3.3.3 Increment F

Increment F includes O&M Projects and Increment A and B projects which meet all the ECIP criteria except project cost ($200,000). Vol. 1 Sec. 4.2.3

Table 3.3 lists Increment F projects and is organized in the same manner as Table 3.1.

TABLE 3.1

SUMMARY OF INCREMENT A & B PROJECTS

Description	Project Cost ($)	Annual Savings Energy	Annual Savings $	Payback (Yrs)	SIR
ECIP Project to Install Energy Monitoring & Control System	285,170	16,314 MB 32,063 KWH	152,920	1.9	5.9
ECIP Project to Weatherize Various Buildings	319,720	10,706 MB 22,414 KWH	102,746	3.1	3.6
ECIP Projects to Replace & Delamp Light Fixtures Various Buildings	228,466	589,505 KWH	70,985	3.2	2.7
ECIP Project to Replace Air Compressors, Bldgs. 54, 209, 403, 640, 672	153,700	272,068 KWH	23,520	6.5	1.5
	987,056	27,020 MB 916,050 KWH	350,171		

TABLE 3.2

INCREMENT A & B IMPACT ON TOTAL ENERGY

	Electricity MB/Yr(1)	Fuel (MB/yr)	Total Energy (MB/Yr)
FY 82	119,000	95,000	214,000
Incr. A & B Reduction	10,626	27,020	37,646
% Reduction	8.9	28.4	17.6

(1) Per DEIS II report electricity converstion 0.0116 $\frac{MB}{KWH}$

TABLE 3.3

SUMMARY OF INCREMENT F PROJECTS

Description	Project Cost ($)	Annual Savings Energy	$	Payback (Yrs)	SIR
Shut Off Boiler in Summer Bldg. 100	140	147.8 MB	1307	0.1	16993
Instruct Occupants on Timeclock Operation-Bldg. 671	0	52 MB 2731 KWH	721	-	>8982
Replace T-Stats-Bldg. 670 Vehicle Bays	256	549 MB	5375	.05	243
Controls Calibration-Relocate OSA Temp. Sensor Bldg. 671	37	24.4 MB 2152 KWH	416	0.1	125
Raise Chilled Water & Cold Deck Setpoints-Bldg. 150	27	3623 KWH	280	0.1	110
Insulate Piping & Equip.-Various Bldgs.	2935	668.2 MB	6542	0.4	25.8
Repair Leaks-Various Bldgs.	1994	27058 KWH 85.9 MB	2941	0.7	16.2
Manual Timer on Lights Various Bldgs.	754	11614 KWH	901	0.8	12.9
Lower DHW Temp. Various Bldgs.	1444	225 MB	1511	1.0	11.8
Interlock Condenser Controls to Chiller-Bldg. 150	1493	19928 KWH	1540	1.0	11.1
Controls Calibration-Raise CHW Temp-Bldg. 672	27	361 KWH	28	1.0	11.0
Separate Dissimilar Functions-Install Air Handler for Calibration-Bldg. 672	12015	643 MB 7551 KWH	6881	1.7	6.6
DHW Recirc. Pump Control Various Bldgs.	1519	9794 KWH	760	2.4	5.4
DHW Flow Restrictors Various Bldgs.	31395	1151.6 MB	8308	2.6	4.5
Replace BFW Pump Controls-Bldg. 54	4716	23328 KWH	1810	2.6	4.1
Reclaim Condenser Heat Bldg. 60	11110	402 MB	3936	2.8	4.1

TABLE 3.3 (Cont'd)

Summary of Increment F Projects (Cont'd)

Description	Project Cost ($)	Annual Savings Energy	Annual Savings $	Payback (Yrs)	SIR
Reduce Infiltration Bldg. 54	1650	48.6 MB	476	3.5	3.3
Separate Dissimilar Functions Separate HVAC System-Bldg. 100	8664	172 MB 8256 KWH	2330	3.7	3.1
Separate Air Handlers & VAV Retrofit-Bldg. 150	42738	148167 KWH -4.3 MB	11454	3.7	2.9
Boiler Stack Economizer Bldg. 54, BP1	35097	662 MB	6481	5.4	2.1
Boiler Stack Economizer Bldg. 202, BP 2	35097	470 MB	4601	7.6	1.5
Reduce North Glass Various Bldgs.	29398	402 MB	3816	7.7	1.5
Replace Steam Line Supply Area	151148	1358.8 MB	13303	11.4	1.0
Replace Elect. DHW Tanks Various Bldgs.	42665	508 MB	2345	18.2	0.5
DHW Tank Timeclocks Various Bldgs.	28634	108 MB	732	39.1	0.3
TOTAL SAVINGS	434,953	7,674 MB 264,563 KWH	88,795		

TABLE 3.4

INCREMENT F IMPACT ON TOTAL ENERGY

	Electricity MB/Yr (*)	Fuel (MB/Yr)	Total Energy (MB/Yr)
FY 82	119,000	95,000	214,000
Incr. F Reduction	3,069	7,674	10,743
% Reduction	2.6%	8.1%	5.0%

(*) Using 11,600 Btu/KWH

		Reference
3.3.4	<u>Impact of Increment F Projects</u>	

Recommendations from Increment F will reduce energy consumption at SIAD by 5%. The $434,853 invested will repay itself in 4.9 years. These projects are tentatively scheduled for implimentation in the fiscal years incidated in Table 8.2.

Table 3.4 summarizes the impact of Increment F projects on the total energy consumption.

3.3.5 <u>Increment G</u>

Increment G includes projects considered for Increments A and B but which have an SIR less than 1. — Vol. 1 Sec. 4.2.3

Table 3.5 lists the Increment G projects.

3.4 OTHER RECOMMENDATIONS

3.4.1 <u>Training</u>

Table 3.6 lists some recommended training classes offered by the U.S. Army and 3 private companies. These classes were selected for their particular applicability to SIAD. Listed is the class, sponsor, cost, schedule (if available) and location. — Vol. 3 Sec. 5.2

3.4.2 <u>Equipment Replacement</u>

Table 3.7 lists various pieces of energy efficient equipment recommended for change-out replacements when old equipment is replaced. A complete description of each type of equipment can be found in Chapter 5 of Volume 3. — Vol. 3 Sec. 5.1

Reference

3.4.3 Electrical Metering

Metering is an energy management tool to help the Facilities Engineer identify potential energy conservation measures that might otherwise be overlooked. Metering itself does not save energy. — Vol. 1 Sec. 3.3.3

TABLE 3.5

INCREMENT G PROJECTS (PROJECTS NOT RECOMMENDED)

Description	Project Cost($)	Annual Savings Energy	Annual Savings $	Payback (Yrs)	SIR
Gas Turbine Cogen.	1,600,000	18,740 MB	124,523	12.8	0.6
Double Glaze Windows Various Bldgs.	347,803	1,375 MB	12,869	27.8	0.4

TABLE 3.6

RECOMMENDED TRAINING FOR F.E.

Course	By	Cost($)	Schedule	Location
Building Loads Analysis & System Thermodynamics (BLAST)	Corps of Engineers	850	3/19-3/24/84	Washington, D.C.
Computer Aided Design for Buildings	"	1265	1/23-1/27/84	Vicksburg, Miss
Economic Study: Milcon Design Application	"	670	3/19-3/23/84	Huntsville, Ala
Energy Conservation for New Buildings	"	580	6/20-6/24/83	"
Energy Conservation in Existing Buildings	"	470	1/16-1/20/84	"
Energy Monitoring & Control Systems (EMCS)	"	585	2/6-2/10/84	Washington, D.C.
	"	585	6/4-6/8/84	Huntsville, Ala
	"	585	7/23-7/27/84	San Antonio, Tex
Mechanical Inspection	"	400	11/15-11/19/83	Atlanta, Georgia
	"	345	12/12-12/16/83	Kansas City, Mo
	"	345	4/9-4/13/84	Atlanta, Georgia
Refrigeration & Air Conditioning Inspection	"	495	1/23-1/27/84	Kansas City, Mo
Solar Active Energy System Design	"	660	6/20-6/24/83	Huntsville, Ala
"	"	560	6/18-6/22/84	"
Solar Passive Energy Design for Buildings	"	660	6/13-6/17/83	"
"	"	615	6/25-6/29/83	"
Building Manager	Johnson Controls Incorporated	425-660		Milwaukee, Wis
Air Conditioning Fund	"	"		"
Maintenance Supervision	"	"		"

TABLE 3.6

RECOMMENDED TRAINING FOR F.E.

Course	By	Cost($)	Schedule	Location
Air Conditioning Controls	Johnson Controls Incorporated	425-660		Milwaukee, Wis
HVAC Energy Management	"	635		"
Reciprocating Equipment Operation & Maintenance Seminar	Trane Company	150-200		Sacramento, Cal
Commercial Unitary Eqpt. Service Seminar	"	300		Sacramento, Cal
Boiler Efficiency Seminar	Boiler Efficiency Institute P.O. Box 2255 Auburn, Ala	200	2 days	Various Loc'ns across U.S.

TABLE 3.7

REPLACEMENT EQUIPMENT

Stack Economizer
Caulking
Weatherstripping
Plastic Curtains
Thermostats
T-Stat Limiters
Rooftop and Window HVAC Units
Timeclocks
Insulation
Exhaust Heat Reclaim Units
Intermittant Ignition Devices
Extra DHW Tank Insulation
Smaller DHW Tanks
Low Temperature Dishwashers
Flow Restrictors
Low Wattage/High Efficiency Lighting
High Efficiency Electric Motor
Variable Speed Motor Controls

	Reference
SIAD presently meters the electrical consumption of 34 buildings on post most of which are privately opperated concessions that are billed monthly. These existing electrical meters should be calibrated since it has been more than 5 years since the last calibration.	

Table 3.8 lists 17 recommended meter locations that, coupled with some one-time calculations of constant loads, will give SIAD an excellent on-going picture of where electrical energy is being consumed.

3.4.4 Fuel Metering

The present system of accounting for fuel oil, propane and coal used in the individual boilers and furnaces is adequate. In order to more accurately estimate the steam consumption of the buildings connected to BP 1, it is recommended to group buildings as shown in Table 3.9.	Vol. 1 Sec. 3.4.8

3.5 ADJUSTED ENERGY PROFILES

Adjusted thermal and electric load profiles were generated from existing load profiles with adjustments made for recommended energy conservation measures (Tables 3.1 and 3.3) and future building plans (Table 3.10). These adjusted profiles were used in the analyses conducted in Increments C, D, and E (Chapters 5, 6, and 7).	Vol. 1 Sec. 4.3

Figure 3-1 indicates both the present and projected monthly fuel consumption for the Cantonment Area. Only the Cantonment Area is addressed because the Increment E analysis concluded that it was the only feasible area for boiler plant centralization (Chapter 7).

Reference

Figures 3-2 and 3-3 indicate the projected average hourly weekday and weekend load profiles. These were used primarily in the cogeneration and boiler plant analyses, Chapter 6 and 7 (Incr. D and E). Figure 3-4 compares the predicted average hourly thermal energy usage for the months of December, April and July.

Figure 3-5 indicates the projected hours per year that thermal and electric demands occur. This data was used for computer modelling in the co-generation analysis (Incr. D).

Figure 8-1 (Chpt. 8) indicates the net impact of the energy measures on SIAD's annual consumption.

TABLE 3.8

RECOMMENDED ELECTRICAL METER LOCATIONS

Area	Location
Cantonment	Bldg. 51, Communications
	54, BP 1
	100, Security
	150, Hospital
	165, 980th Mess
	170, Chapel
	1218, Community Club
	2067, Library, Gym, Post Office, Concessions
Supply	Main feeder to Supply Area Warehouses
	Main feeder to Bldg. 201, 202, 206 and 207
	Bldg. 205
	Main feeder to Bldgs. 402, 403, 556 and 564
	Bldgs. 599, Special Weapons Area 2
	Bldg. 640, Ammo Maintenance
Magazine	Main feeder to Special Weapons Area 1
	Bldg. 672
	Bldg. 1218

TABLE 3.9

RECOMMENDED STEAM METER LOCATIONS

Area	Location
Cantonment	6" S main to Bldgs. 52 and 53
	6" S main to Bldgs. 59, 60, 74 and 75
	6" S main to Bldgs 2, 150 and 165

TABLE 3.10

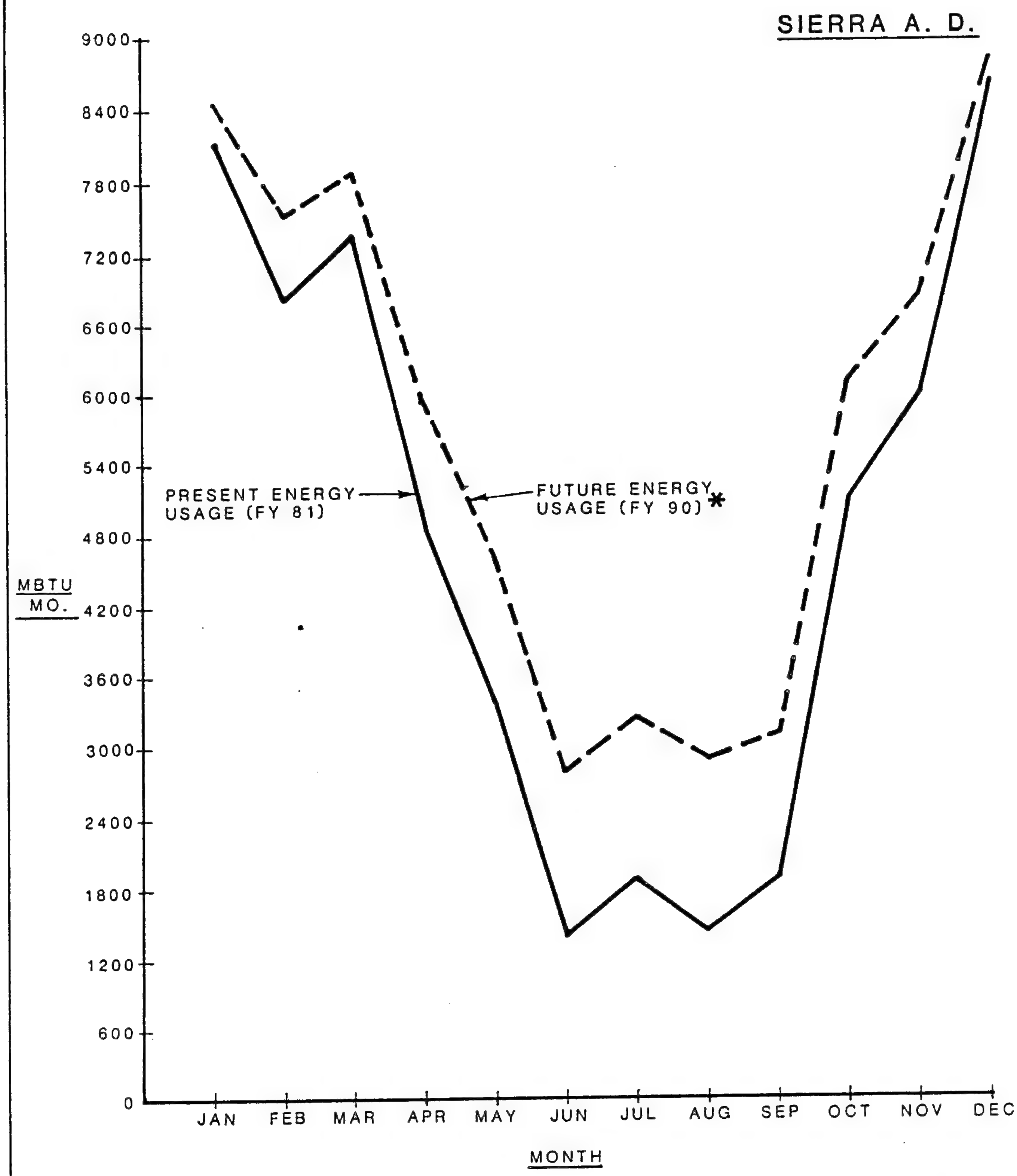
ENERGY IMPACT OF FUTURE PROJECTS*

FY	Project	Area (ft^2)	Bldg. Being Replaced	Type AC	Est. Annual Impact MB/Yr	Est. Annual Impact KWH/Yr
83	Solar Heat Pool	2,000				
84	Gymnasium	16,400		Evap.	160	65,600
	Comm Center Add.	11,000	None	AC	120	100,000
85	EM Barracks w/Admin	23,220	1201, 1202, 1203 1204, 1208, 1214, 1010	AC	-2600	223,000
	Heating Plant Refuse/Coal	N/A				
86	Ammo Surveil. Work	12,930		None	100	52,000
	" " "	1,000		AC	13	10,000
	Container Loading Dock	N/A				
	Recreation Center	12,700	7, 1217	Evap.	-670	446,000
87	Intrustion Alarm Sys.	N/A				
	Multi-Op Ammo Maint.	26,000		None	210	104,000
	Modify 100 Igloo Doors	N/A				
88	Army Cont. Ed/Lib	15,000		AC	200	150,000
	Ammo Proc. Facility	11,050		None	90	44,000
	Headquarters & Admin.	45,980	84, 63, 201	Evap.	-250	-18,000
89	Temporary Lodging	2,200	26	Evap.	-630	-74,000
	F.E. Complex	15,000	75, 74	Evap.	-1800	-41,000
	Community Center	85,600	2067, 2068, 2069 2071, 59, 60	Evap.	-3100	-1,120,000
90	EOD Facility	9,206		Evap.	120	55,000
	Consol. Maint. Supply	56,000 10,000	52, 53, 55	None AC	-6000	-41,000
	Box & Crate Shop	23,900		None	-480	33,000

TABLE 3.10 (Cont'd)

FY	Project	Area (ft^2)	Bldg. Being Replaced	Type AC	Est. Annual Impact MB/Yr	Est. Annual Impact KWH/Yr
Long Range	Fire Station (assume 2000 ft^2 conditioned).	12,000		Evap.	40	24,000
	Prop Disposal Facility	12,000	316,317	Evap.	30	51,000
	Rail Equip. Maint.	7,200	61	None	-970	17,000
	Small Area Storage		68			
	Small Area Process	21,000		Evap.	270	126,000
	Modular Disposal Proc.	9,000		Evap.	120	54,000
	General Purpose Wrhs.	46,400		None	370	186,000
	Contam. Waste Proc.	3,500		None	30	14,000
NAF Projects	Golf Course	N/A				
	Open Mess & Club	4,400	1218	Evap.	-310	63,000
	Bowling Center	7,800	1019	Evap.	-270	-2,000
Future Projects Not Scheduled	Outdoor Equip. Checkout	5,000		None	40	20,000
	Resrv. Housing & Training	23,000		Evap.	460	276,000
	Clubhouse	23,000		Evap.	230	92,000
	Family Housing	46,000		Evap.	920	552,000
	Pro Shop	5,000		Evap.	50	20,000
	Paint Shop	6,000		None	48	24,000
	T-58 Addition	11,000	None	Evap.	143	66,000

* Annual Impact = Energy consumption of new bldg. less energy consumption of bldgs. being replaced.

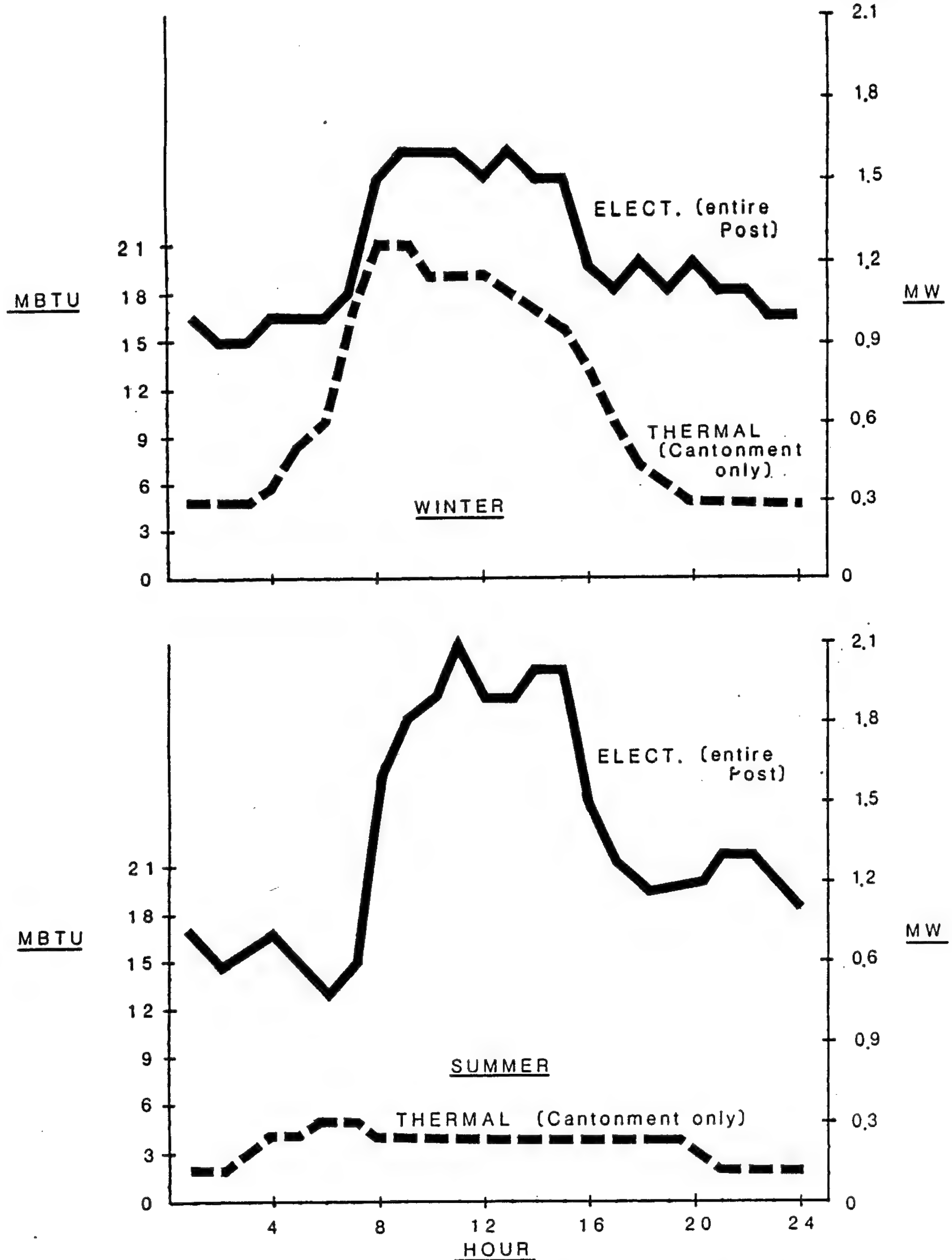


MONTHLY THERMAL PROFILE FOR CANTONMENT FY 81 vs. FY 90

* FY 90 includes all ECM's and central distribution

FIG. 3-1

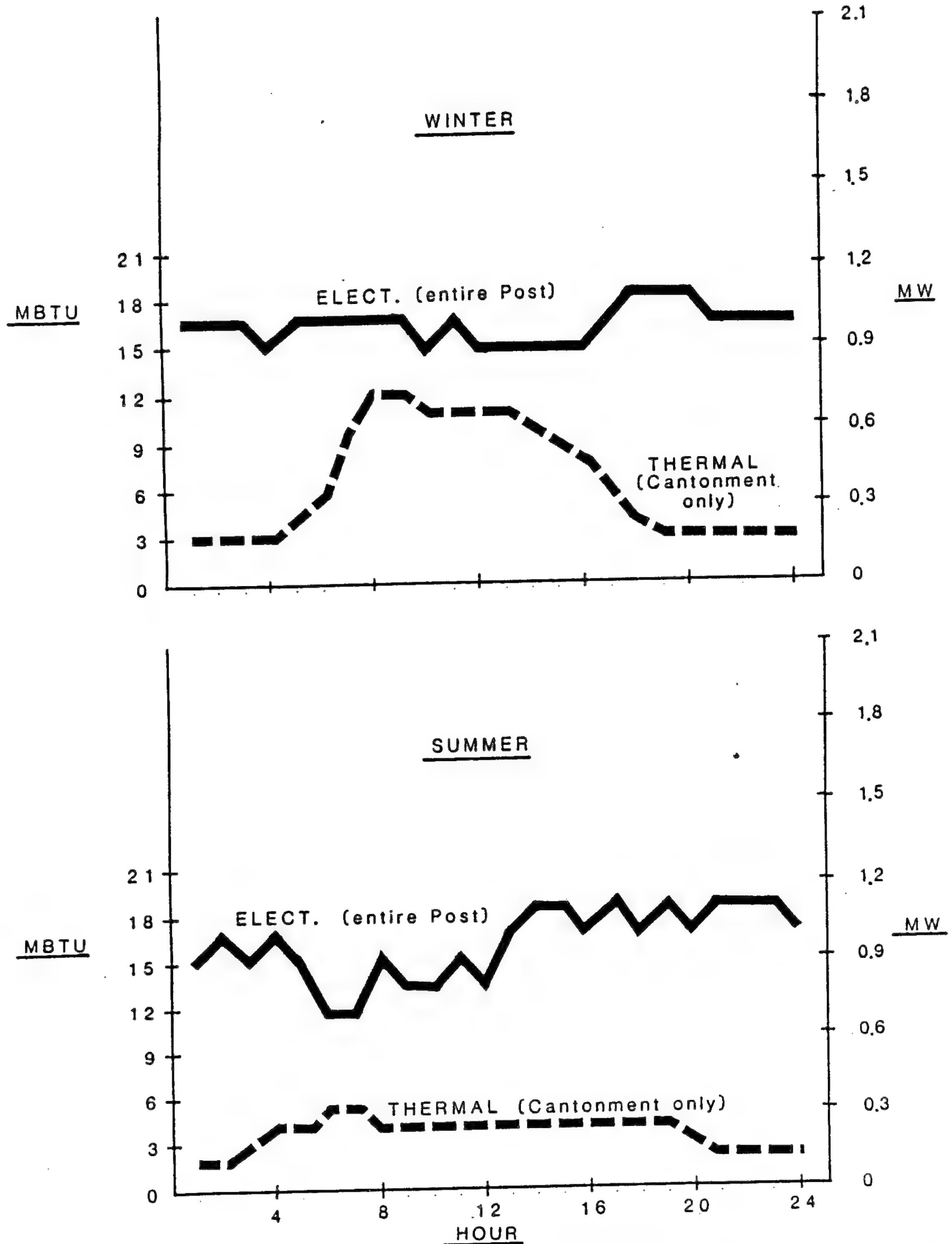
SIERRA A. D.



SUMMER AND WINTER WEEKDAY THERMAL/ELECTRIC PROFILES, FY 90

FIG. 3-2

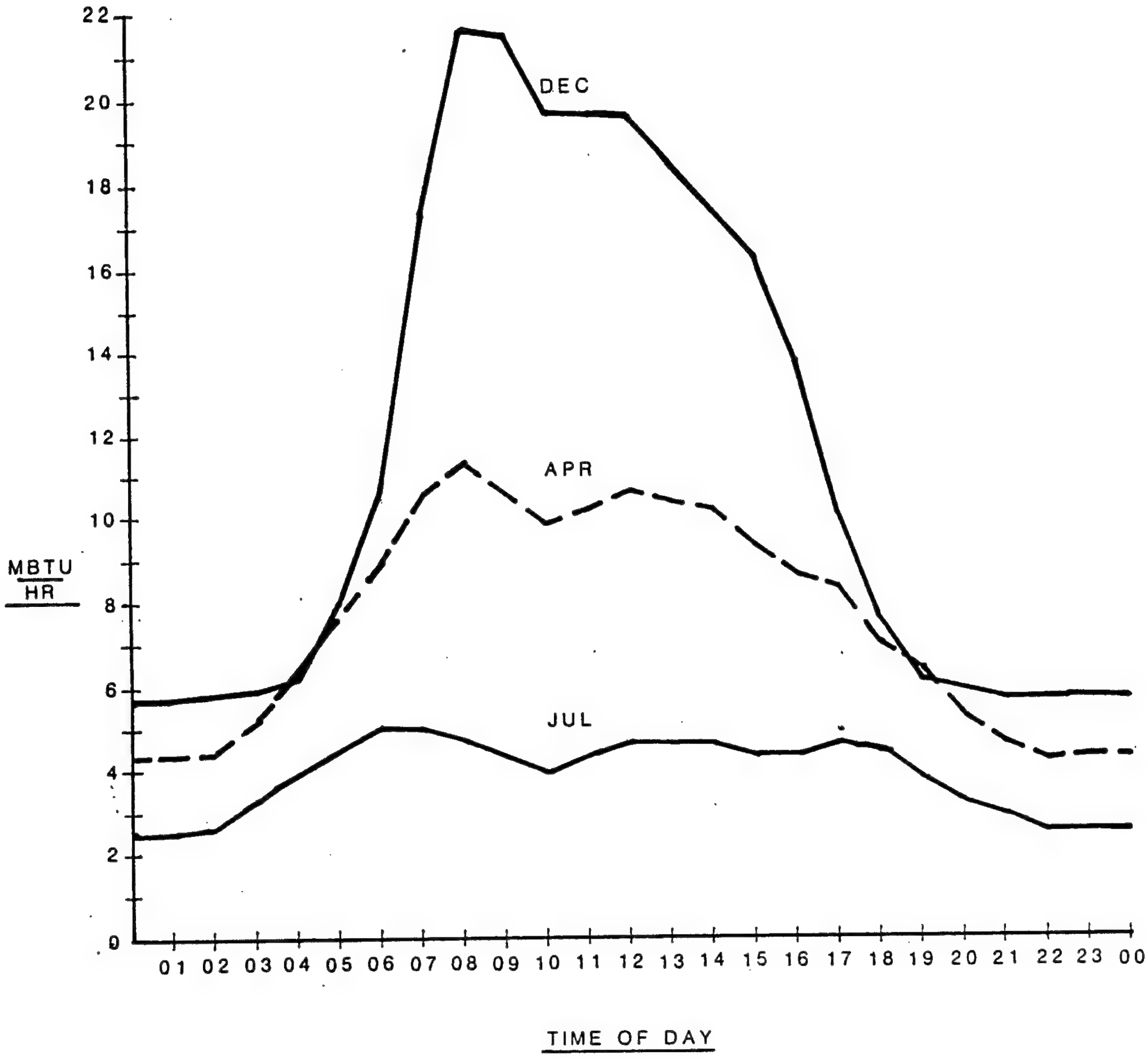
SIERRA A. D.



SUMMER AND WINTER WEEKEND THERMAL/ELECTRIC PROFILES, FY 90

FIG. 3-3

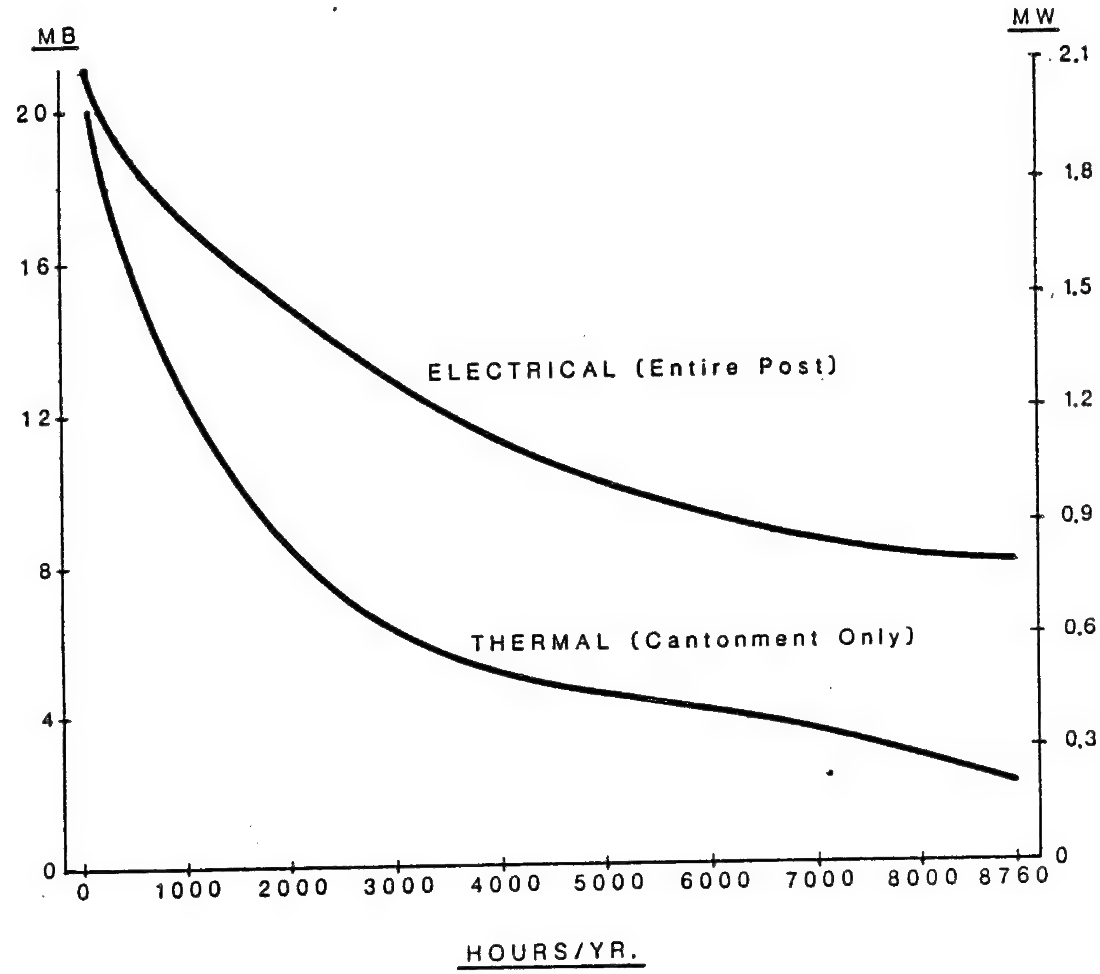
SIERRA A. D.



AVERAGE DAILY PROFILES FOR VARIOUS MONTHS, FY 90

* Curves for Cantonment only w/ central distribution and all ECM's

FIG. 3-4



ANNUAL OCCURRENCE OF THERMAL & ELECTRIC LOADS, FY 90

FIG. 3-5

CHAPTER 4

ENERGY MONITORING & CONTROL SYSTEM (EMCS) (Incr. B)

4.1 PROCEDURE

Reference: Vol. 1, Sec. 5.2

The analysis of the economic feasibility of an Energy Monitoring and Control System (EMCS) for SIAD was conducted using the following procedure:

1. Field Data: Gather field data.
2. Screen Systems: Identify buildings/systems with potential energy savings through the use of an EMCS.
3. Select EMCS Programs: Select applicable EMCS energy conservation features to be considered.
4. Field & Facility Costs: Estimate sensor/actuator and connection costs.
5. EMCS Costs vs. Conventional Controls: Compare sensor/actuator and facility connection costs with the cost of conventional controls by EMCS feature, and eliminate those features that can be accomplished with conventional controls at less cost.
6. Identify Points: Determine approximate number and type of points, by building.
7. Energy Savings: Quantify poential energy savings by building or system type.
8. Preliminary Economic Analysis: Conduct a preliminary economic analysis considering items 4 and 7 by building or system type.
9. Eliminate Uneconomical Systems: Temporarily desregard systems and permanently disregard entire buildings that are not individually economically justifiable.
10. Add Transmission & Central Computer Costs: Estimate cost of entire EMCS considering sensor/actuator and facility costs only for those buildings being justified in item 8.

Reference

11. Conduct Economic Analysis: Prorate cost of transmission and CCU on to cost of each point which passed preliminary screening.

12. Add Marginally Feasible Systems: If EMCS is economically feasible, add those systems temporarily disregarded in 9 in descending order of economic attractiveness without sacrificing the feasibility of the entire EMCS.

13. Final Economic Analysis: Conduct final economic analysis of entire EMCS.

14. Alternate Solutions for Uneconomical Systems: Consider alternative means of control for buildings that cannot be economically connected to an EMCS.

4.2 ANALYSIS OF HARD-WIRE SYSTEM

4.2.1 Field Data

The majority of the required field data for the EMCS anlaysis was gathered concurrently with the field data collection for Increments A, B, F, and G. Information on the existing data transmission media (DTM) was obtained from Communications. SIAD's telephone system is capable of handling data transmission. — Vol. 1 Sec. 5.3.1

4.2.2 Screen Systems

Generally, the existing mechanical systems were found to be small, unsophisticated, and possibly not ideal for an EMCS. Systems with satisfactory existing conventional controls were not considered for inclusion in the EMCS. — Vol. 1 Sec. 5.3.2

4.2.3 EMCS Programs

The following EMCS software functions were considered: — Vol. 1 Sec. 5.3.3

Schedule Start/Stop
Optimum Start/Stop
Duty Cycling
Demand Limiting
Occupied/Unoccupied
Day/Night Setback

4.2.4 Field & Facility Costs

Reference: Vol. 1, Sec. 5.3.4

The preliminary analysis used the following material and labor costs:

TABLE 4.1

HARD WIRE EMCS COSTS

Facility Connection Costs	Mat'l	Labor	Total
FID w/power supply	$2,400	$810	$3,210
Modem	$ 425	$108	$ 533
MUX	$ 920	$108	$1,028
			$4,771
Point Costs			
Temp./Humidity	$110/440 (1)		
Start/Stop	$ 61/244 (2)		
Status	$ 33/264 (3)		
Control Point Adjustment	$186/745		
Sensor/Actuator Costs (4)			
Temp/Humidity	$ 62	$132	$ 194
Start/Stop	$ 68	$132	$ 200
Status	$ 82	$154	$ 236
Control Point Adjustment	$ 196	$114	$ 310
Sensor Connection Costs			
Conduit, ½" EMT w/2 #18	$ .65/LF	$1.74	$2.39

Notes:

(1) $110/pt or $440 for card w/4 pt. capacity.
(2) $61/pt or $244 for card w/4 pt. capacity.
(3) $33/pt or $264 for card w/8 pt. capacity.
(4) Cost includes field instrument and 50 LF of conduit and wire.

4.2.5 EMCS vs. Conventional Controls

Reference

Vol. 1
Sec. 5.3.5

A cost comparison between EMCS and conventional controls was made for each of the functions listed in paragraph 4.2.3 as well as multiple functions on a single system. The comparisons indicated that, in all cases, hard-wire EMCS control was more costly than conventional control. Therefore, it was concluded that a hard-wire EMCS is not economically feasible at SIAD.

4.3 ALTERNATE SYSTEMS

Vol. 1
Sec. 5.4

The alternate methods of control considered were FM radio control, both with two-way and one-way communications, and current carrier control. An FM based, one-way communications EMCS was selected for further consideration for the following reasons:

1. The cost of two-way FM control systems approach the cost of hard-wire systems, which were shown not to be economically feasible.
2. The decentralized nature of the mechanical equipment at SIAD does not favor a current carrier system which would require numerous network couplers and amplifiers.
3. The functions required by SIAD are typically those functions most easily provided by an FM based, one way EMCS.

An FM based EMCS, as considered, consists of receiver units, base station with antenna and Central Control Unit (CCU), and is depicted in Figure 4-1.

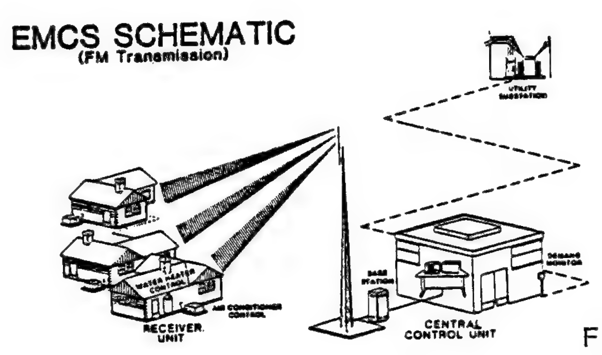


FIGURE 4-1

4.4 ANALYSIS OF 1-WAY FM BASED EMCS — Reference

4.4.1 Procedure

Because of the differences between a hard-wire and FM based EMCS, the procedures described in paragraph 4.1 were modified to: Vol. 1 Sec. 5.5.1

1. Field Data: Gather field data.
2. Screen Systems: Identify equipment within each building/system with potential energy savings through the use of an EMCS.
3. Select EMCS Programs: Select applicable EMCS energy conservation features to be considered.
4. Identify EMCS Field Equipment: Determine approximate number of receivers corresponding to number of pieces of equipment identified in item 2.
5. Field & CCU/BS Costs: Estimate receiver, other field equipment and Central Control Unit/Base Station installation costs.
6. EMCS vs. Conventional Controls: Compare the costs from item 5 with the cost of conventional controls for each EMCS feature identified in item 3, and eliminate those features that can be accomplished with conventional controls at less cost.
7. Savings: Quantity potential energy savings and non-energy savings for each piece of equipment identified in item 2.
8. Preliminary Economic Analysis: Conduct a preliminary economic analysis considering the cost established in item 5 vs. the savings calculated in item 7. Eliminate buildings who's inclusion in the EMCS is not economically justified.
9. Final Economic Analysis: The final economic analysis is conducted when, through iterations of item 8, all buildings considered produce SIR's greater than 1 or no buildings remain to be considered, in which case the EMCS project would be considered not economically feasible.

The collection of field data and identification of potential energy savings as described in para. 4.2.1 and 4.2.2 also pertain to an FM based EMCS.

4.4.2 EMCS Programs

	Reference
The EMCS software functions considered are those listed in paragraph 4.2.3 except for Optimum Start/Stop which requires feedback from the devices to the CCU.	Vol. 1 Sec. 5.5.2

4.4.3 Field Equipment & CCU/BS Costs

722 pieces of equipment were identified for possible inclusion in the EMCS.	Vol. 1 Sec. 5.5.4

This portion of the analysis used the following material and labor costs:

TABLE 4.2

FM BASED EMCS COSTS

CCU/BS Costs	Mat'l	Labor	Total
CCU	$24,000	$4,725(175 MH)	$28,725
CCU/Demand Limiting Package	$ 1,200	$ 324(12 MH)	$ 1,524
Base Station w/antenna, tower, coax cable	$ 6,000	$3,105(115 MH)	$ 9,105
Training	-	$4,725(175 MH)	$ 4,725
Demand Limit Signal Transmission Equip.	$10,000	$1,620(60 MH)	$11,620
			$55,699
Field Costs			
Receiver Unit	$ 100	$ 27	$ 127
Sensor Costs			
Hi/Li Limit	$ 50	$ 27	$ 77
Sensor Connection Costs			
Conduit, ½ EMT w/2 #12	$ .65/LF	$ 1.74/LF	$ 2.39/LF

4.4.4	FM Based EMCS vs. Conventional Controls	Reference
	A cost comparison between EMCS and conventional controls was made, the results of which indicated the FM based EMCS as more economically attractive than conventional controls.	Vol. 1 Sec. 5.5.5
4.4.5	Savings & Economic Analysis	
	The potential savings and Savings to Investment Ratio (SIR) were calculated for those buildings considered for inclusion in the EMCS. Successive iterations were performed, eliminating buildings with unsatisfactory SIR's and dividing the Central Control Unit and Base Station costs amongst the remaining buildings on a per point basis.	Vol. 1 Sec. 5.5.6 & 7
	The results are indicated on Table 4.3. This analysis shows an EMCS containing 511 points produces an SIR of 5.97.	
4.4.6	Recommendation	
	We therefore conclude that an FM based EMCS is a viable energy conservation project and should be pursued through a request for ECIP funds. DD 1391's for this project are included in Chapter 1 of Volume 2.	
4.4.7	Input/Output Summary Tables	
	Building Summary Tables and I/O Summary Tables for the FM based EMCS are included with the programming documents for this project, Chapter 1, Volume 2.	Vol. 1 Sec. 5.5.9

TABLE 4.3

EMCS Analysis

Bldg No.	T or P	EMCS Programs	Energy Savings Fuel (MB/Yr)	Type (O,P)	Elect (KWH/Yr)	Equip Demand (KW)	Demand Savings ($/Yr)(*1)	Receiver Units (ea.)	Hi/Lo T'Stat (ea.)	Add'n Equip (note *)	Field Costs ($)(*2)	Savings to Investment Ratio (SIR) Iteration (*3) #1	#2	#3	#4	#5
1	P	DC,DL,S S/S			948	10.9	31.96	20	19		6283	0.09				
2	P	DC,DL			256	2.33	5.78	9	9		2916	0.05				
7 +	*T	D/N,DC,DL	428	O	1247	5.8	24.24	5	5		1620	17.17	15.91			
21-25 +	T	D/N,DC,DL,S S/S	160	O	1686	13.8	51.66	20	20		6480	1.73	1.60			
26	*T	DC,DL,S S/S			658	9.5	28.49	19	18		5959	0.07				
27 +	P	D/N,DC,DL	64.4	O	328	1.6	6.44	2	3		845	5.29	4.97			
51 +	P	D/N,DC,DL,S S/S	145	P	2604	26.5	127.24	3	2		775	10.59	9.67			
52-53 +	T	D/N,DC,DL,S S/S	593	O	980	8.9	34.17	26	24	4(2)	9794	4.01	3.75			
54	P	DL				16	190.56	1			127	0.00				
55 +	T	D/N,DC,DL,S S/S	299.1	O	1116	4.57	21.59	17	16	4	6193	3.23	3.01			
58 +	T	D/N,DC,DL,S S/S	186	P	365	2.07	7.70	5	7		2014	4.57	4.29			
61 +	T	D/N,DC,DL,S S/S	233	O	816	3.57	16.03	12	11	4	4573	3.43	3.21			
		Page Totals	1777.50 331.00	Oil Propane	11004		545.86	139	134		47579.00					

\+ Bldg recommended for EMCS

T = Temporary DC = Duty Cycling S S/S = Scheduled Start/Stop D/N = Day/Night Setback

P = Permanent DL = Demand Limiting

TABLE 4.3 (Cont'd)

Bldg No.	T or P	EMCS Programs	Energy Savings Fuel (MB/Yr)	Energy Savings Type (O,P)	Energy Savings Elect (KWH/Yr)	Equip Demand (KW)	Demand Savings ($/Yr)(*1)	Receiver Units (ea.)	Hi/Lo T'Stat (ea.)	Add'n Equip (note *)	Field Costs ($)(*2)	Savings to Investment Ratio (SIR) Iteration (*3) #1	#2	#3	#4	#5
63 +	T	D/N,DC,DL,S S/S	239.3	O	230	4.77	16.75	3	2	4	1657	10.07	9.58			
74 +	T	D/N,DC,DL,S S/S	388.8	O	1451	16.3	60.32	32	29	4	10659	2.42	2.24			
75	T	DC,DL,S S/S			597	7.7	24.02	3	2		775	0.45				
79	T	DC,DL,S S/S			502	5.23	18.88	9	8		2719	0.11				
84	T	DC,DL,S S/S			667	8.1	25.01	5	4		1423	0.28				
100 +	P	DC,DL			1313	14.2	65.4	2	1		451	1.66	1.51			
122,124	P	DL,S S/S			89	1.5	5.36	1			127	0.33				
150	P	DL				90	223.31	1			127	0.00				
165	P	DL				65	161.28	2			254	0.00				
166-168	P	DC,DL			3702	9	50.02	72	72		23328	0.08				
170	P	DC,DL,S S/S			3791	48.3	192.17	21	19		6410	0.36				
176-195 +	P	D/N,DC,DL,S S/S	1315.14	P	3575	18.7	71.01	120	120		38880	1.63	1.51			
201	T	DC,DL,S S/S			1072	9.4	24.96	27	26		8551	0.07				
		Page Totals	628.10 1315.14	Oil Propane	16989		938.49	298	283		95361.00					

+ Bldg recommended for EMCS

TABLE 4.3 (Cont'd)

Bldg No.	T or P	EMCS Programs	Energy Savings Fuel (MB/Yr)	Type (O,P)	Elect (KWH/Yr)	Equip Demand (KW)	Demand Savings ($/Yr)(*1)	Receiver Units (ea.)	Hi/Lo T'Stat (ea.)	Add'n Equip (note *)	Field Costs ($)(*2)	Savings to Investment Ratio (SIR) Iteration (*3) #1	#2	#3	#4	#5
203	P	DC,DL,S S/S			577	6.9	24.05	3	2		775	0.44				
206 +	P	D/N,DC,DL,S S/S	272.7	O	922	6.9	44.66	3	2	4	1657	11.76	11.19			
207 +	P	D/N,DC,DL,S S/S	324.9	O	1010	7.7	46.65	7	6	4	2953	7.55	7.09			
208 +	P	D/N,DC,DL,S S/S	1055.2	O	514	5.8	22.69	14	13	4	5221	13.21	12.33			
209 +	P	D/N,DC,DL,S S/S	1781.9	O	696	35.17	394.93	11	9	4	4052	29.12	27.18			
210 +	P	D/N,DC,DL,S S/S	999.9	O	344	6.17	24.53	14	13	4	5221	12.50	11.68			
316 +	T	D/N,DC,DL,S S/S	278.4	P	220	5	17.32	6	5		1747	7.36	6.78			
317 +	T	D/N,DC,DL	96.9	P	29	.27	.61	2	2		648	6.98	6.47			
401 +	P	D/N,DC,DL,S S/S	555.4	P	611	4.67	19.17	10	9	4	3925	6.91	6.47			
403	P	DC,DL			781	34.6	395.57	14	13		4339	0.11				
541 +	P	D/N,DC,DL,S S/S	373.5	O	998	8.3	32.28	14	13		4339	5.55	5.13			
544 +	P	D/N,DC,DL,S S/S	495.6	O	290	1.9	6.35	3	2		775	38.83	35.47			
564 +	T	D/N,DL,S S/S	359.8	O	296	4	17.87	2	1		451	47.10	42.61			
		Page Totals	5663.50 930.70	Oil Propane	7288		1046.68	103	90		36103.00					

+ Bldg recommended for EMCS

TABLE 4.3 (Cont'd)

Bldg No.	T or P	EMCS Programs	Energy Savings Fuel (MB/Yr)	Energy Savings Type (O,P)	Energy Savings Elect (KWH/Yr)	Equip Demand (KW)	Demand Savings ($/Yr)(#1)	Receiver Units (ea.)	Hi/Lo T'Stat (ea.)	Add'n Equip (note #)	Field Costs ($)(#2)	Savings to Investment Ratio (SIR) Iteration (#3) #1	#2	#3	#4	#5
593 +	P	D/N,DC,DL,S S/S	119.3	O	1039	5.5	23.22	9	8		2719	2.96	2.73			
634 +	P	D/N,DC,DL,S S/S	189.26	O	389	1.8	7.55	8	7		2395	5.02	4.63			
640 +	P	D/N,DL,S S/S	295.2	O	90	51	582.4	4	2		902	22.24	20.12			
670-672	P	DL				132	629.25	4			508	0.00				
1010 +	T	D/N,DC,DL	295.2	O	200	1.13	4.03	8	8		2592	7.26	6.73			
1101-1120 +	P	D/N,DC,DL,S S/S	1178.96	P	5979	26.7	115.48	120	120		38880	1.50	1.39			
1201-1214 +	T	D/N,DC,DL	2832.6	O	1054	9.6	23.82	12	12		3888	46.32	42.91			
1217 +	T	D/N,DC,DL	284.9	O	176	1.6	3.97	2	2	4	1530	13.34	12.86			
1218 +	*T	D/N,DC,DL,S S/S	92.1	O	424	7.4	23.28	8	7	4	3277	1.96	1.84			
1223 +	T	D/N,DC,DL,S S/S	60.1	O	539	2.57	10.48	3	2		775	5.06	4.62			
2071 +	*P	D/N,DC,DL,S S/S	320.7	O	532	7.7	24.02	4	3		1099	18.20	16.69			
		Page Totals	4489.36 1178.96	Oil Propane	10422		1447.50	182	171		58565.00					
		Grand Totals	12558.46 3755.80	Oil Propane	32063		1947.86	511	486		172987					

+ Bldg recommended for EMCS

CHAPTER 5

NON-PETROLEUM BASE ENERGY SOURCES (Incr. C)

5.1	SCOPE	Reference

The following potential energy sources were investigated for possible use at SIAD. — Vol. 1 Sec. 6.1

- Bituminous Coal
- Geothermal
- Biomass including:
  - Forest Residue
  - Wood Pellets
  - On-Post Waste
  - On-and Off-Post Refuse
  - Desert Harvesting
- Solar Heat
- Wind

The results and recommendations of the analyses follow.

5.2 COAL

Coal prices (currently $2.60/MB FOB SIAD) are forecast by the California Energy Commission to remain below those of oil and gas. Low-cost reserves are extensive, so that mining costs should not rise much as a result of depletion. Competition among sellers, combined with utility bargaining power, should keep prices from rising to the levels of oil or gas prices. According to the CEC, the greatest potential for cost increases stems from the monopoly power of the railroads--some part of the route from any coal field to California is controlled by a single railroad. — Vol. 1 Sec. 6.2

Coal is readily available with no reason to believe that there will be any change in the near future. Prices have increased an average of 24% per year over the past 3 years. DOE has projected a 13.9%

Reference

per annum rise in cost (discounting inflation) from 1981-85 and 1.3% per annum rise from 1985-90. The CEC projects an average rise of 3% per annum (above inflation) from 1985-90.

Availability and cost make coal an attractive alternative to fuel oil. It is recommended that coal be considered as a future source of solid fuel.

5.3 GEOTHERMAL

Geothermal remains an enticing unknown. An investigation of all known surveys shows little exploration activity or visual evidence of geothermal either directly on Post or to the south, east or west. However, 3 miles to the north lies the beginning of a Known Geothermal Resource Area (KGRA). This area has served as a testing grounds for several different exploration methods. Results of the tests have been plotted against the known wells to determine the relative validity of the testing methods. USGS and Lawrence Livermore Labs have been two of the major participants in the tests which have been conducted at various times over the past 20 years.

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Geothermometry tests to the south of SIAD indicate the possibility of geothermal sources. Geothermometry, though one of the better tests, is not considered proof positive. Geothermometry, electrical resistivity, and heat flow profiles are the first three steps recommended among those exploration methods showing reasonable correlation to actual known sites.

Vol 1
Fig. 6-4
& 6-5.

It is recommended that SIAD conduct the following tests in the order they appear and only continue on to the next test if the "Criteria for Continuing" is met.

Reference

1. Water Chemistry

Measure: Conduct water chemistry and temperature profile analyses of existing wells at SIAD to establish a geothermometer for each. — Vol. 1 Sec. 6.3.5

Cost: \$1000-\$2000 per well

Criteria For Continuing: Indication of at least 180°F aquifer.

2. Electrical Resistivity Tests

Measure: Conduct electrical resistivity analyses to establish contours.

Cost: \$50,000-\$100,000

Criteria For Continuing: Contours similar to those of existing geothermal sources.

3. Heat Flow Profiles

Measure: Drill shallow wells in areas identified by electrical tests and measure and plot heat flow profiles of new and existing wells.

Cost: \$10,000-\$15,000 per well

Criteria For Continuing: Temperature gradient profiles indicating temperature increase with depth and predicted depth of acceptable temperature fluid.

4. Drill Well

Measure: Depending on level of certainty from previous tests drill either small diameter deep test hole or full size well holes.

Cost: \$50,000-\$1,000,000 per hole depending on hole size and material encountered.

5.4 BIOMASS

The following known on- and off-Post biomass resources were investigated: — Vol. 1 Sec. 6.4

- Forest Residue
- Wood Pellets
- On-Post Waste (boxes, crates, tires, paper)
- On- and Off-Post Refuse (residential garbage)
- Desert Harvesting

Reference

Table 5.1 shows the quantities available and the estimated cost of the various biomass resources.

5.4.1 Forest Residue

Vol. 1 Sec. 6.4.1.1

Forest residue is defined as residue from logging operations, fire damage, insect damage and controlled thinning. The 1.8 million tons (see Table 5.1) of forest residue that is available annually is three times the amount required by all known and planned biomass users in Lassen County.

The heat content of forest residue is fairly low (5,000 Btu/lb) due to the high moisture content of the wood chips which indicates that a larger storage area would be required (compared to coal) to house the fuel.

The U.S. Forest Service estimates that 50% of the 4,000 miles of public and forest roads within a 100 mile radius of SIAD are open year around so that winter harvesting is possible, although it is recommended that a wood fueled boiler plant have a storage yard containing at least a 30 day supply of wood chips.

The cost of the forest residue is estimated at \$2.30/MB plus \$0.18/MB per hour trucking charge. A round trip between SIAD and the local logging areas would take between 3 and 8 hours yielding a delivered cost per MB of \$2.84/MB to \$3.74/MB (See Table 5.1).

Reference

5.4.2 Wood Pellets

Wood pellets are considered one of the higher quality biomass resources due to the uniformity of size (generally 3/4" to 1 1/2" by 1/4 to 1/2" diameter) and heat content (8500-8800 Btu/lb) which result in easier handling and more stable combustion. The nearest manufacturer of wood pellets, Modoc Lumber Co., is located approximately 200 miles from SIAD in Klamath Falls, Oregon. Their present quoted price is $55/ton ($2.84/MB) without transportation. Assuming $45/hr per 25 ton live floor truck delivery costs would add $1.80/MB for a total delivered price of $4.64/MB. Vol. 1 Sec. 6.4.1.2

TABLE 5.1

Summary of Annual Biomass Availability & Delivered Cost by Type of Source

Source	Quantity (tons/yr)	Heat (Btu/lb)	Total MB/yr	Cost $/MB At Source	Cost $/MB Transport	Cost $/MB Revenue	Cost $/MB Total	Remarks
Forest Residue	1.8×10^6 (green)	5,000	18×10^6	2.30	0.54-1.44 (1)	0	2.84-3.74	2/2/83 quote f/Bollman Logging Susanville.
Wood Pellets	Unlimited	8,600	-	2.84	1.80 (2)	0	4.64	12/1/82 quote f/Modoc Lumber Co., Klamath Falls, Oregon
				2.84	0.54-1.44 (1)	0	3.38-4.28	Assume local supply
On-Post								
Boxes/Crates	600 (dry)	8,000	9,600	0	0.85	0	0.85	Per telcon 1/25/83 Mr. Arnold, SIAD Production Planning & Control and telcon 3/3/83 Mrs. Marr SIAD Property Disposal and telcon Lt. Costas 3/7/83.
Cardboard	36	8,000	576	0	0	-0.09	-0.09	
Paper	38	8,000	609	0	0	0	0	
Tires	16	8,500	272	0	0	-0.17	-0.17	
On-Post Refuse	700 (3)	4,500	6,300	0	6.21	0	-6.21	Per telcon 1/83 Mr. Ernie Woods, SIAD Bldg.Grnds & Mrs. Richardson of F.E. 3/83.
Off-Post Refuse	18,000	4,500	162,000	-	-	-	-	Lassen College has contracted to purchase all refuse for cogen. plant per telcon 2/83 w/Darryl Hatch, Lassen County Public Works.
Desert Harvesting	1-4 $\frac{\text{tons}}{\text{acre}}$	6,000	12-48 $\frac{\text{MB}}{\text{acre}}$	-	-	-	-	Harvest costs unidentifiable considered poor potential source
			18.2×10^5					
Estimated Lassen County Demand 1993 663,000 ton/yr			6.6×10^6 MB/yr					

(1) assuming 3 hrs min., 8 hrs max. per round trip @ $45/hr (per Bollman quote)
(2) assuming 10 hrs round trip delivery from nearest mfr. (See Remarks)
(3) assumes 60% of 1,220 ton/yr is burnable.

5.4.3 On-Post Waste

Reference

SIAD currently disposes of 600 tons/yr of ammunition and equipment packaging (70-80% wood boxes/crates, 20-30% packing), 36 tons/yr of cardboard, 38 ton/yr of paper products (paper, computer cards, etc.) and 16 tons/yr of tires. The packaging materials cost approximately $8,200 per year to dispose. The quantity of waste has been stable over the past 5 years and there is no reason to believe the quantity will change in the near future. SIAD sells the cardboard for $1.10/ton and the tires for $0.008/lb. There appears to be no seasonal fluctuations in the waste quantities. The average heat content of each is summarized in Table 5.1.

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Although the ammunition and equipment boxes would be a very good energy source, the boxes are impregnated with pentachlorophenol (PCP) which when burned can produce toxic substances in the form of dioxins, chlorophenols, and acid mists. For this reason, they are not recommended as a potential source of energy and the present practice (burning in a secluded spot on post) should be investigated.

5.4.4 On-Post Refuse

SIAD collects 4 loads (at 5.8 tons per load) per week of post refuse. Assuming 60% combustibles (per visual inspection) SIAD generates approximately 700 tons/yr of combustible refuse. Since the refuse is collected and disposed of on post there would be no cost avoidance associated with transportation if the refuse were used for fuel on post. The quantities are so small and the cost of handling and separating so high, that on-post refuse is not recommended as a fuel source.

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5.4.5 Off-Post Refuse

Reference

There are four off base landfills located in Lassen County - Herlong, Susanville, Westwood and Bieber. Herlong's landfill (the closest) acquires a maximum of 5 tons/day of refuse. The total refuse dumped at the four landfills is approximately 50 tons/day. However, Lassen College has an agreement with the landfills to purchase the refuse for a 4 MW biomass cogeneration project (requires 100 tons/day of fuel). The project was scheduled to begin construction in April, 1983. Therefore, off-post refuse is not recommended as a potential energy source for SIAD.

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5.4.6 Desert Harvesting

Two independent sources, Dr. James Young of the University of Nevada, Reno, Renewable Natural Resource Center and Drs. Kenneth Foster and William Brooks of the University of Arizona, Office of Arid Lands Studies, agree that the combustible biomass production of arid land is low-approximately 1-4 dry tons/acre/year (equivalent to 12-48 MB/acre per year). Drs. Foster and Brooks in their report to EPRI (Electrical Power Research Institute) conclude:

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> "The technology base for informed decision-making regarding arid land plants appears to be very limited. Compared to more traditional biomass resources, the production of arid lands biomass appear to be low..."

Based on their conclusion and previous discussions of other biomass sources this source of biomass was not pursued further.

5.4.7 Recommendations

Forest residue and wood pellets are the most attractive biomass sources available to SIAD. The amount of forest residue available far exceeds SIAD's needs. The viability of wood pellets hinges on reducing

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transportation costs by establishing a local supplier. Given a stable source of wood chips SIAD could either purchase and operate it's own pelletizer or convince the chip supplier to do the same. In either case the incremental cost to pelletize chips is estimated to be \$0.55-\$0.60/MB more than the cost of chipping only.

It is recommended that forest residue be used in the proposed solid fuel boiler plant as a supplementary fuel to coal. The forest residue (which contains no sulfur) would be used in conjunction with coal whenever the sulfur dioxide emissions of the boiler plant approach the emission standards set by Lassen County. This situation will only occur during winter months. SIAD would also be able to switch to wood as the primary source if and when it is less expensive. At the time of this publication coal was approximately 8% less expensive (\$2.60/MB) than wood (\$2.84/MB).

On-post cardboard and paper are recommended as potential energy sources. The ammunition boxes and crates are not recommended due to the health risks of combusting the preservative used in the boxes. Similarly old tires are not recommended because the quantity is far too small to justify the special combustion equipment.

It is recommended that SIAD give or sell it's on-post refuse to Lassen College for the biomass cogeneration project that is currently under construction at the campus.

Since all off-post refuse will be consumed by Lassen College and the quantity of on-post refuse by itself is too small to justify the boiler and fuel handing systems required, refuse as a biomass energy source is not recommended.

Reference

Since desert harvesting is an unproven technology and previous studies for the State of Nevada and EPRI have concluded that "the production of arid lands biomass appears to be low," desert harvesting as a biomass energy source is not recommended at this time.

5.5 SOLAR HEATING

Three types of solar heating systems were investigated: Vol. 1 Sec. 6.5

- Domestic hot water heating for offices and residences
- Space pre-heating system for building 165
- Make-up water pre-heating system for the boiler plant

For each type of solar heating system two types of sub-systems were analyzed:

- Active (automatically controlled, no user involvement required)
- Passive (user involvement is required to make system operate)

The only solar system whose SIR exceeded 1 was a passive domestic hot water heating system for residential use. Since the system requires user involvement to operate and since the consequences of neglecting the system could result in frozen water pipes this system is not recommended. Vol. 1 Sec. 6.5.7

Two active systems (space pre-heat system for building 165 and hot water heating for bldg. 26) have an SIR equal to 0.90 (SIR=0.90) and although they can not be recommended presently, they may become economically feasible in the future if fuel prices escalate faster than currently predicted.

Reference

5.6 WIND

On-post wind generation is not a viable energy alternative. The results of the analysis indicate an SIR of 0.07 and a 100+ year payback. Vol. 1 Sec. 6.6

Should SIAD decide to investigate wind farming at an off-post location such as Shaffer Mountain where the annual wind velocity is more attractive, we offer the following suggestions:

1. The reliability of wind turbines decreases with size. A 25 KW turbine is the largest size recommended.
2. Smaller turbines yield a higher KW/acre.
3. Select a readily accessible mountain top site near existing power lines, i.e. Shaffer Mountain.

5.7 RENEWABLE ENERGY SOURCE RECOMMENDATIONS

The most attractive resources available to SIAD are coal, wood chips produced from forest residue and wood pellets. It is recommended that coal be used as the primary fuel for the proposed solid fuel boiler plant with wood chips and wood pellets (wood contains no sulfur) used as necessary to reduce sulfur dioxide levels to acceptable standards.

Coal is preferred over wood chips and pellets because coal is currently 8% less expensive than wood chips ($2.60/MB vs. $2.84/MB) and presents fewer problems in the fuel handling process.

Geothermal investigation is highly recommended based on the steps outlined in section 5.3.

There are currently no feasible solar heating or wood energy projects available for implementation at SIAD.

CHAPTER 6

COGENERATION, INCINERATION & GASIFICATION(Incr. D)

Reference

6.1 SCOPE

Increment D addressed the feasibility of installing a cogeneration system and/or a solid waste heating plant using solid fuels supplemented with refuse derived fuels and waste oils. Vol. 1 Appendix

The cogeneration system was required to use solid fuel (either biomass or coal) as the primary energy source and oil as a secondary source, if necessary.

The solid waste heating plant was required to use on-post refuse (off-post refuse, if feasible) to produce steam for space heating.

6.2 COGENERATION

Cogeneration is defined as the simultaneous production and use of thermal and electrical energy. The scope of the analysis was confined to the following: Vol. 1 Section 7.2

a. Primary fuel source is coal and wood with fuel oil as backup (see Chapter 5 for conclusions regarding solid fuel energy sources).

b. The Army is willing to sell excess electricity to local utility company per the conditions established by the Public Utility Regulatory Policies Act of 1978 (PURPA).

c. Thermal and electric loads assume all Increment A, B, & F energy measures have been implemented and the central steam distribution system has been expanded to include most of the buildings on base (see Chapter 3 for load profiles).

6.2.1 Utility Company Contractual Arrangements

Reference

There are two basic types of "buy-back" arrangements for cogenerators; 1) Buy-all, Sell-all, and 2) Offset-load, Sell-surplus. In terms of system operation they are the same; the way in which the cogenerator is compensated is greatly different. The computer program used to model the various cogeneration options calculates system performance in both modes. Schematics of both modes are shown in Fig. 6-1 and 6-2.

Vol. 1 Section 7.2.[illegible]3

Vol. 1 Section 7.2.1

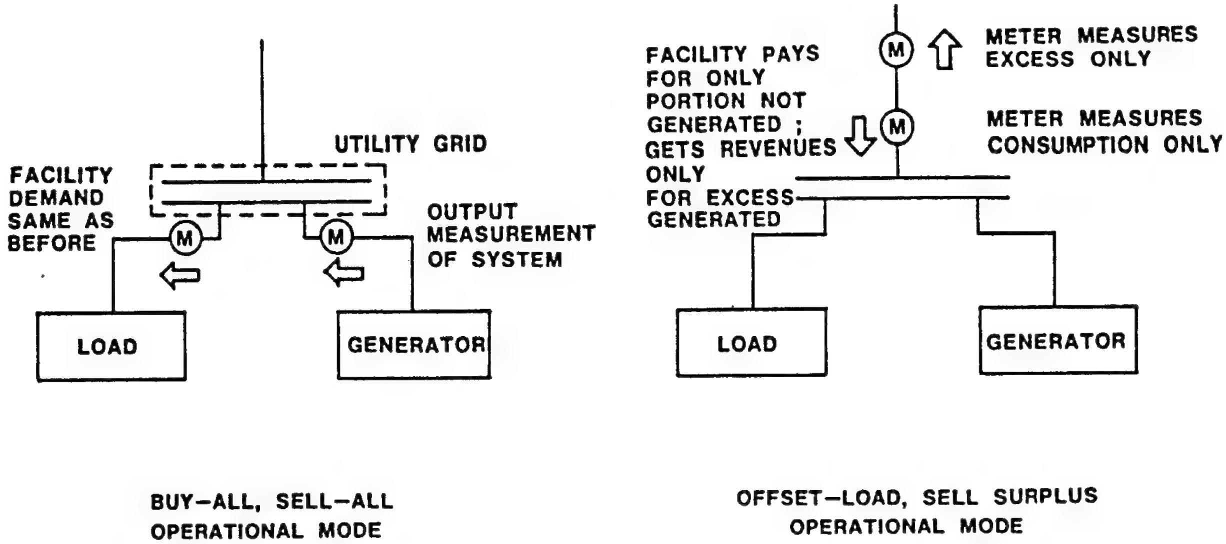
a. Buy-all, Sell-all (BASA): In this mode the cogenerator agrees to purchase all his electrical needs on exactly the same rate schedule as before. Therefore the cogenerator's electrical bill does not change. However, the utility agrees to buy all the electricity generated, regardless of quantity or time of day, at the agreed upon "avoided cost" rate structure. Standby charges are not normally part of the rate structure in this mode. The turbine/generator system in this case becomes a "profit center" whose objective is simply to minimize costs and maximize revenues.

b. Offset-load, Sell-surplus (OLSS): In this mode the cogenerator offsets his load with his system and therefore pays the utility only his net consumption. If he generates more than he uses, the utility buys only that excess at the agreed upon "avoided cost" rates. Standby charges are a part of the rate structure.

Vol. 1 Section 7.2.1.3

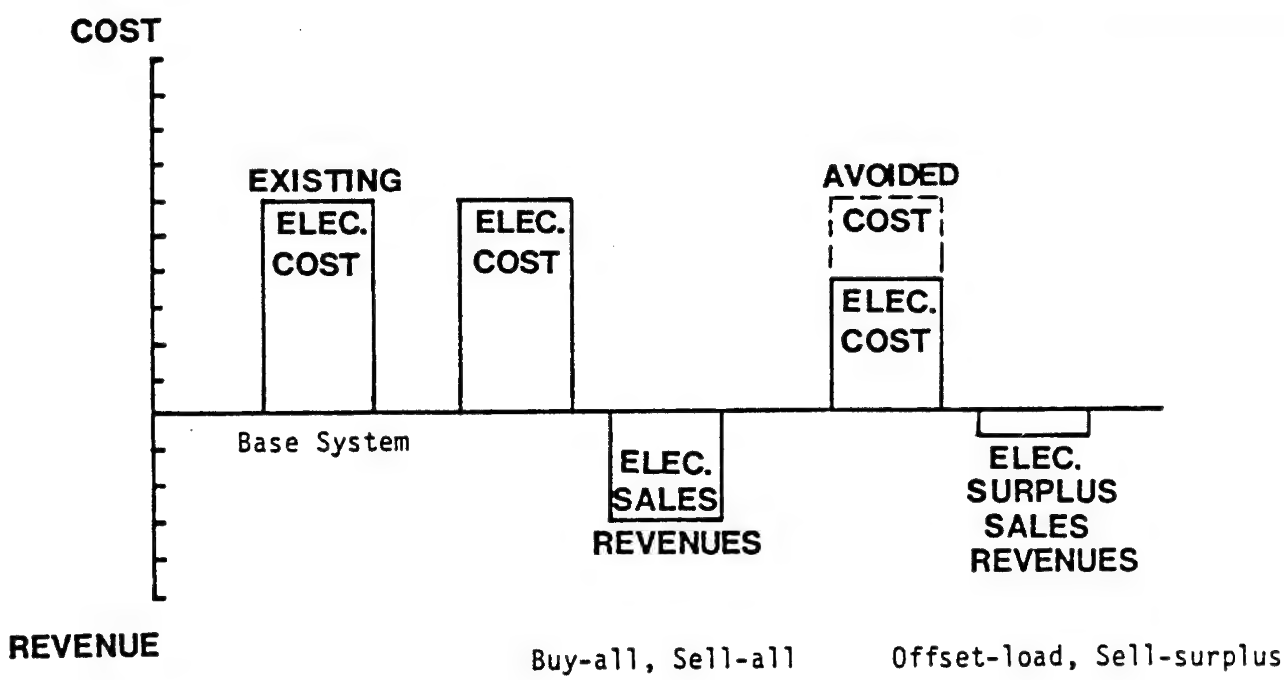
6.2.2 Calculations

Purchased electrical costs are calculated by the program using the "typical" hourly usage (KWH) and demand (KW) profiles developed from utility company records. The computer program modelled these costs based on an algorithm of the current billing structure. Table 6.1 lists the assumptions used.



COGENERATION OPERATIONAL MODES

FIG. 6-1



SCHEMATIC of ELECTRICITY COST & REVENUES

FIG. 6-2

TABLE 6.1

MAJOR COST ASSUMPTIONS FOR COGENERATION

ELECTRICITY RATES[1]

° Purchase cost		
	Base Charge	\$230/mo
	Demand Charge	\$3.97/KW/mo
	Usage Charge on-Peak (6:30A-10:30P)	\$0.07769/KWH/mo
	off-Peak (10:30P-6:30A)	\$0.07759/KWH/mo
° Buy-back rate (per P.G. & E.)		
	Non-time of day	\$0.0585/KWH
	Capacity credit	\$99/KW/yr

FUEL RATES

° Coal	\$2.60/MB
° Biomass	\$2.84/MB

(1) Rates based on the local utility, C.P. National, wheeling power to P.G. & E (reference Vol. 1, Sec. 7.2.2.1)

Reference

6.2.3 Equipment Analyzed

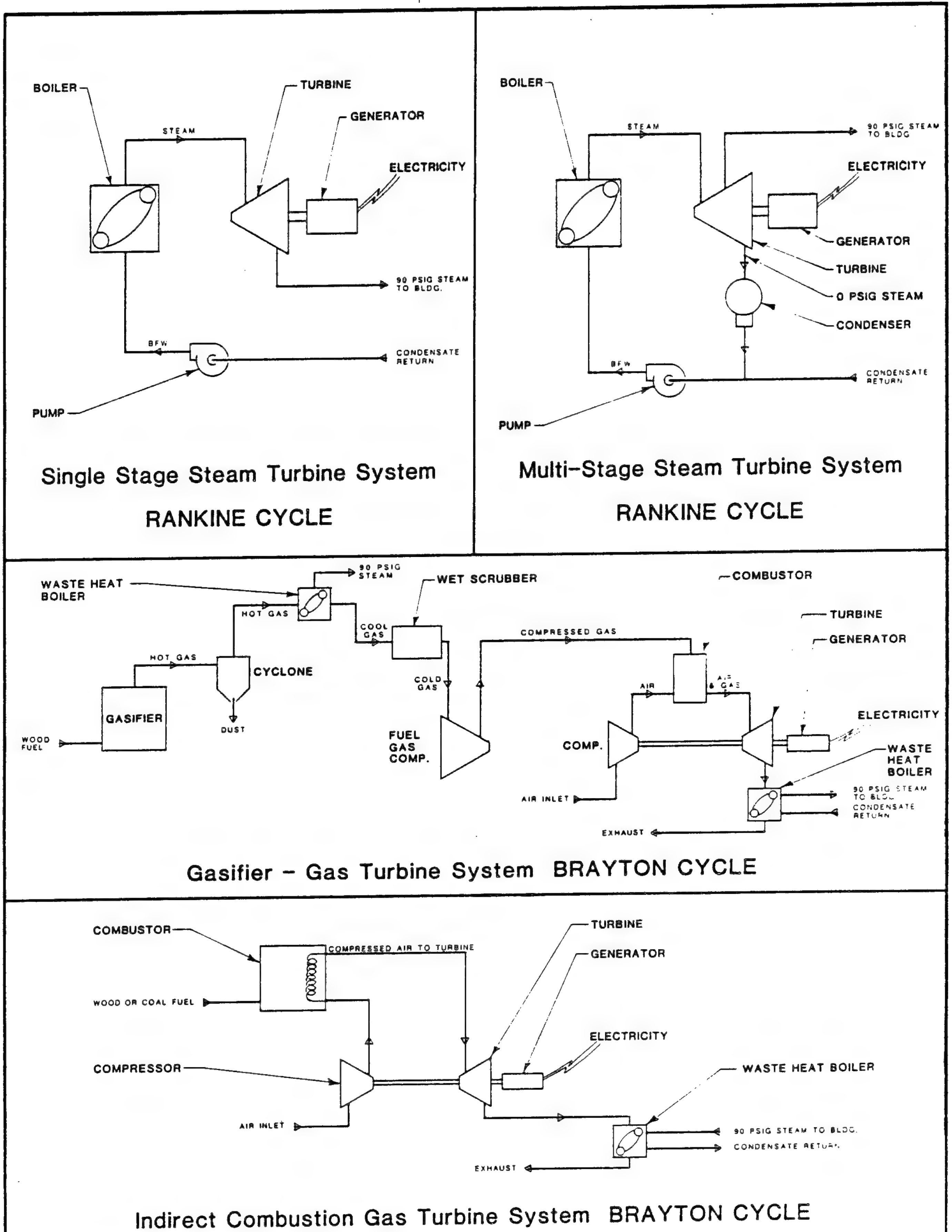
The scope requirement to use solid fuel as the primary energy source limited the alternatives to 3 types of power cycles (see Fig. 6-3). — Vol. 1 Section 7.2.3

- Steam Rankine cycle (steam turbine)
- Direct Brayton cycle (gas turbine) or gas engine fueled by a low Btu producer gas from a gasifier.
- Indirect Brayton cycle (gas turbine with external combustor) powered by air from a boiler heat exchanger.

Gas turbines offer a higher electrical conversion efficiency (20 to 30%) than steam turbines (3-15%) which is in SIAD's favor since it's ratio of electrical-to-thermal energy use varies from 0.40 to 3.0 on a BTU basis. However, the requirement to use solid fuel adds a level of sophistication and associated problems to the scheme which industry has not yet solved. Though the use of gas turbines for cogeneration is becoming quite common (several under construction or already working in California) and reciprocating engines have been used for years, no low BTU fuel fired turbines or engines have been successfully operated. Solutions to solid fuel gasification problems appear to be 2-5 years in the future. Therefore, the cogeneration analysis for Sierra Army Depot was confined to steam turbines exclusively. — Vol. 1 Section 7.2.3.4

6.2.4 Systems Analyzed

13 cases were preliminarily analyzed using single and multi-stage steam turbines at various pressures. Based on the conclusions of the preliminary screening two types of steam turbines were analyzed. — Vol. 1 Section 7.2.4



affiliate of integrated energy systems

Koenigshofer Engineers
energy consultants • designers
Sacramento, CA

EP DK

RANKINE / BRAYTON CYCLE SCHEMATICS

FIG. 6-3

Reference

- Single-stage back pressure turbine with all steam exhausting at 90 psig. — Vol. 1 Section 7.2.5

- Multi-stage extraction turbine with part of the steam extracted at 90 psig and the remainder going to condensors.

Each was computer modelled at various inlet pressures and flow rates and compared on an hourly basis to the post electrical and thermal needs to determine the usable and wasted energy. All electrical energy produced was either used by SIAD or sold to the utility company. Thermal energy was used as needed with the remainder going to waste. Unfortunately, the closer the system comes to matching SIAD's electrical needs, the more steam is wasted.

6.2.5 Conclusions and Recommendations

In the case of governmental agencies the economics of cogeneration are proportional to two basic criteria: — Vol. 1 Section 7.2.5.3

1. Using or selling as much of the steam and electricity generated as possible.

2. Running the system at peak capacity as much as possible.

The best case for using as much of the steam and electricity as possible is to size the system for the minimum KW and steam load (base load) that SIAD experiences. That way one is assured of minimal wastage. However, SIAD's minimal loads are so small that the installed cost per peak KW ($/installed KW) are too high to justify the project.

If, on the other hand, a larger system is installed decreasing the $/installed KW either the running time at peak capacity fluctuates to match the load or the system runs at peak capacity but wastes the excess steam that SIAD cannot use. In SIAD's case, the fluctuations in steam and electricity from day to night and

Reference

season to season would keep the system running at part load most of the year, which means the installed cost per annual KWH is high. In either case the system efficiency decreases.

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Section 7.2.5.3

13 combinations were analyzed based on the assumption that the Cantonment Area would be centralized to one steam system (optimal condition for cogeneration). Based on the recommendation of minimal centralization (see Chpt. 7) the 2 best cases were re-analyzed using the smaller steam loads. The net result (see Table 6.2) is that no government-owned cogeneration system is economically feasible at SIAD.

It is recommended that SIAD do not purchase a cogeneration system. Instead it should pursue third-party ownership by which the owner (private entrepreneur) would install and own a system on post for which SIAD could negotiate land leases and/or reduced steam and electricity rates. Tax deductions and exemptions make cogeneration more attractive to private-companies than government agencies.

TABLE 6.2

SUMMARY OF FINAL COGENERATION ANALYSES

INPUT				OUTPUT			
Case	Turbine	KW Peak	MWH	Total Fuel Costs	First Year Savings	Project Cost (K$)	SIR
1	Single stage, 260 psig, 580°F	65	155	59	9,300	361	0.33
3	Single stage, 700 psig, 750°F	121	286	61	17,200	761	0.29

6.3 INCINERATION

Reference

Controlled air incineration is the process of burning solid waste (fuel) under controlled conditions to produce heat which can be vented to the atmosphere or fed into a waste heat boiler. Incineration offers SIAD two advantages: — Vol. 1 Section 7.3.1

- A portion of SIAD's steam requirements can be met by using an incinerator/waste heat boiler system, thus reducing the boiler plant's fuel oil usage.
- SIAD would eliminate exisitng disposal costs, since all on-post refuse would be burned in the incinerator.

6.3.1 Equipment Analyzed

Three types of incineration systems were considered: — Vol. 1 Section 7.3.2

- Controlled air incinerators
- Rotary kilns
- Fluidized bed incinerators

The rotary kiln and fluidized bed incinerators were dropped from consideration because they are not available in the small size range required (70 HP to 140 HP). SIAD has approximately 1,300 tons/yr of burnable refuse available.

6.3.2 Systems Analyzed

Three sizes of controlled air incinerators were analyzed to determine which was most economical. The boiler horsepower rating of the three systems ranged from 70 HP to 140 HP. The units are a ram fed cascading type of incinerator with induced draft waste heat boiler. The fuel handling system consists of a truck dump site from which the refuse is transferred by a front-end loader to a belt-fed shredder. A schematic of the system is shown in Fig. 6-4. — Vol. 1 Section 7.3.3

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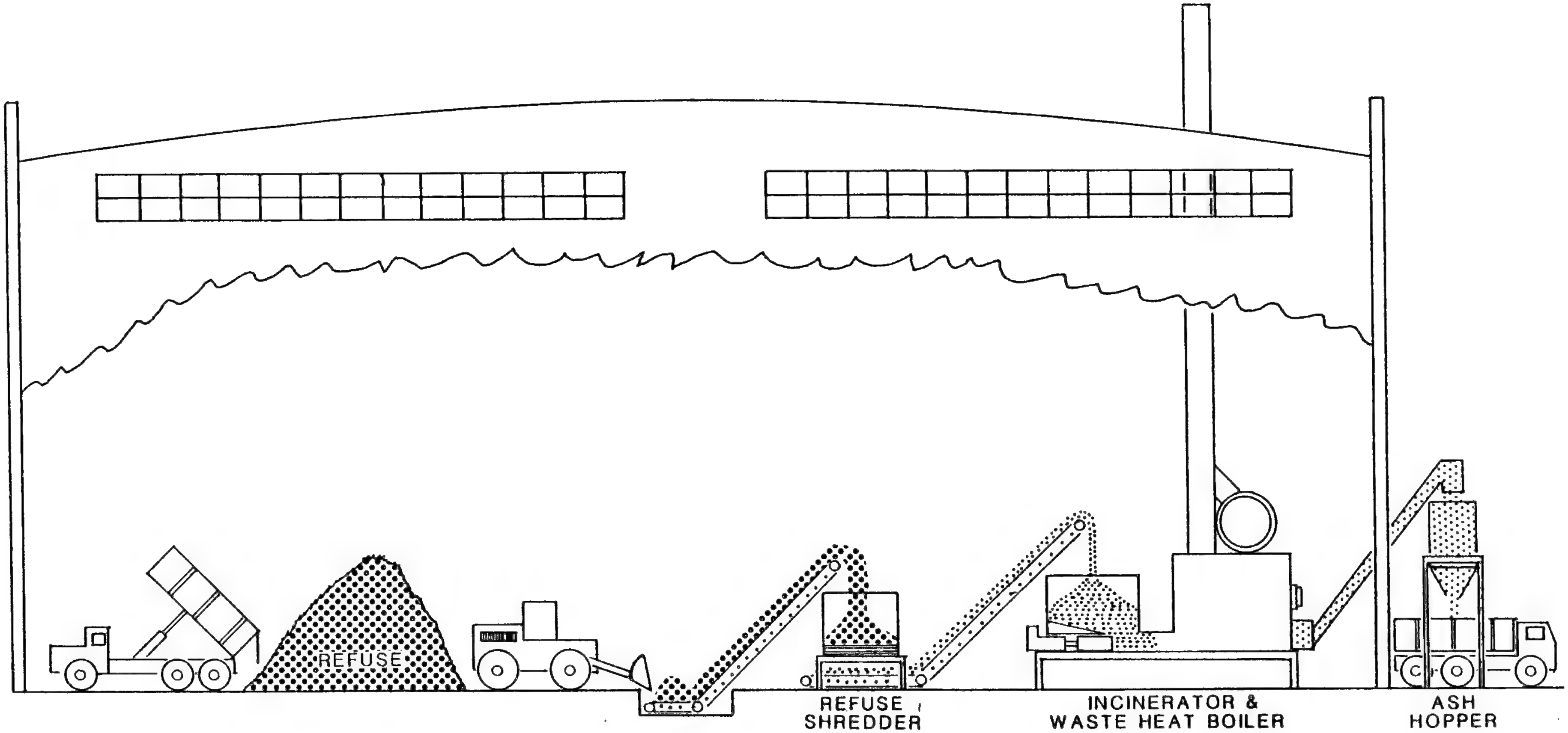

INCINERATOR & WASTE HEAT BOILER FUEL HANDLING SYSTEM

FIG. 6-4

Reference

Each system was augmented with some amount of purchased wood chips to maximize the output of the incinerator. As the incinerator size increased the ratio of wood chips to refuse increased. This modelling procedure was used in order to take advantage of the small incremental increase in price for larger units, i.e. an incinerator with 100% more capacity than the small one costs only 12% more to install.

6.3.3 Conclusions and Recommendations

The SIR's for the three systems ranged from 1.06 for the small incinerator to 1.19 for the large incinerator (see Table 6.3). Vol. 1 Section 7.3.4

The solid fuel boiler plant recommended in Chapter 7 has a higher SIR than the incineration system which means that the boiler plant is a better investment and therefore should be considered first. With most of the steam being produced by the boiler plant the steam demand from the incineration would be so low that the system would never pay for itself. Installation of an incinerator/waste heat boiler system is not recommended.

TABLE 6.3

SUMMARY OF INCINERATION OPTIONS

Option	Incinerator Capacity (lbs/hr)	Capital Cost ($ thousands)	Annual Savings (MB/yr)	Annual Savings ($/yr)	SIR
1	500	917	15,460	75,548	1.06
2	750	955	17,717	86,618	1.17
3	1,000	1,024	19,156	93,765	1.19

Reference

6.4 GASIFICATION

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Gasification is a pyrolytic process whereby a solid fuel is subjected to high temperatures in the absence of sufficient oxygen for complete combustion to occur. The fuel is changed to a low-BTU combustible gas which can then be used in the same manner as natural gas with some modifications to the piping systems and burners on the existing boilers.

Needless to say, this is a process with a great future because of the enormous number of gas and oil-fired furnaces and boilers in the country. A great deal of research has taken place in gasifying coal and wood and some prototype systems have been installed. However, very little research has been done on refuse gasification and no commercial systems have been developed. Therefore, refuse gasification is not recommended at this time.

CHAPTER 7

CENTRAL BOILER PLANT (Incr. E)

Reference

7.1 SCOPE

Increment E addresses the feasibility of installing a solid fuel-fired central boiler plant serving all or discrete parts of the post. Existing distribution systems are reused as much as possible. The analyses assumed that all practical energy conservation measures developed earlier in this study will have been implemented when the central boiler plants are built. Various combinations of systems and equipment were analyzed and are discussed below. Vol. 1 Appendix 1

The analyses included:

- Central Plant vs. Multiple Smaller Plants
- Solid Fuel Boiler Options
- Boiler, Fuel Handling, Pollution Control, Storage and Siting Recommendations
- Central Distribution System Layouts
- Building Equipment Retrofits necessary to convert to steam heating.

7.2 CENTRAL PLANT vs. MULTIPLE SMALLER PLANTS

7.2.1 Reduced System Efficiency

Since the Supply Area and Cantonment Area are the least distance apart (1.4 miles) and represent 83% of the fuel consumption, centralization of these two areas was considered first. Calculations of the annual piping heat loss were based on a 6" steam line with 2" fiberglass insulation supplying 90 psig steam 8 months per year and a 3" condensate return line with 1 1/2" fiberglass insulation returning 180°F condensate. The new piping would loose 4275 MB/yr ($41,800 per year at 1982 oil prices) and reduce the system efficiency for BP 2 from the present 72% to 51%. Vol. 1 Section 8.4. Vol. 1 Appendix 8

7.2.2 Conclusion

Reference

Based on the excessive piping losses due to the distance between distinct areas and the relatively small loads of each of the areas it is not recommended that Supply Area or any other area be connected to the Cantonment Area central heating system. Therefore, the remaining analyses addressed centralization of the Cantonment Area only and conversion of the remaining areas to solid fuel individually. See Volume 1 for a discussion of the condition of all boiler plants and distribution systems (Table 2.3 of this text summarizes all existing central plants and their condition).

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Section 8.4.2

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Section 3.4

The areas of post were divided as follows for the remaining analyses:

- Cantonment
- Supply
- All Other Areas

The areas were grouped in this manner because Cantonment consumes 67% of the total annual energy usage, Supply 16%, and the remaining six areas using 17% (see Table 7.1).

TABLE 7.1

FUTURE FUEL REQUIREMENTS OF

VARIOUS AREAS ON POST

Area of Post	Energy Consumption, MB/yr FY 81 Adjusted(1)	Estimated Future(2)	% of Total	Distance to Cantonment BP (miles)(3)
Cantonment	64,000	45,000	67	-
Supply	18,300	11,000	16	1.4
Ammo Renovation	4,200	2,940	4.4	1.8
Ammo Shipping	600	420	0.6	1.9
Guided Missiles Surveillance	900	630	0.9	4.6
Ammo Maintenance	2,600	1,820	2.7	5.2
Special Weapons 1	2,700	1,890	2.8	4.1
599 Area	5,300	3,710	5.5	6.1
		67,420		

(1) FY 81 actual consumption increased by 12% to account for warmer than normal year for purposes of calculating future MB/yr.

(2) Assuming energy measures from Increment A, B, & F implemented.

(3) See Site Plan in Chapter 3.

7.3 COMBUSTION EQUIPMENT ANALYZED — Reference

7.3.1 Central Boilers

Four types of boilers were investigated for the central boiler plant analysis: — Vol. 1 Section 8.6

1. Spreader-Stoker
2. Suspension Burning
3. Fluidized Bed
4. Gasification

The results of the equipment analysis indicate that stoker firing offers a proven method of combusting coal and wood (the recommended solid fuels - see Chpt. 5). The technology has been proven in service on a large number of units over a period of many years. Single units that have the capacity to meet the requirements of this project are standard models. The fuel handling and ash handling systems for the stoker-fired unit are the least complex of any alternative. No other system appears to offer any improvements over the stoker system in maintenance, operation costs or fuel costs.

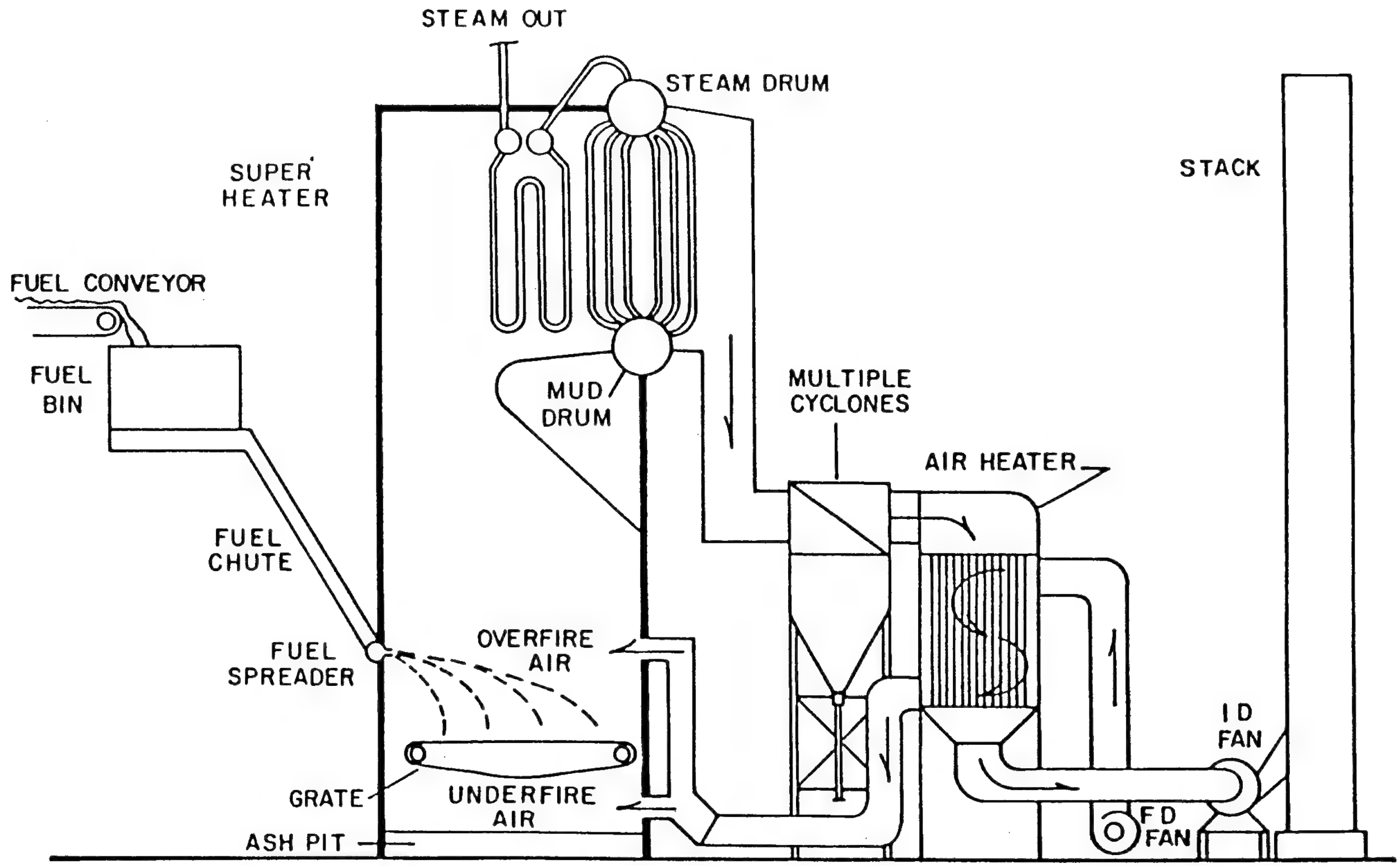
Therefore, the stoker-fired conventional boiler is recommended for the new central plant boilers at SIAD.

7.3.2 Individual Boilers/Furnaces

Individual boilers, where not recommended for centralization, were either converted to solid fuel or completely replaced by new solid fuel boilers. The criteria for conversion rather than replacement were:

- capacity less than 600-700 KBH
- annual consumption at least 200 MB/yr
- estimated remaining life of boiler being converted at least 10 years

A solid fuel burner conversion system recently developed by Heat Harvester Corporation of North Carolina served as the basis for those systems



STOKER - FIRED BOILER

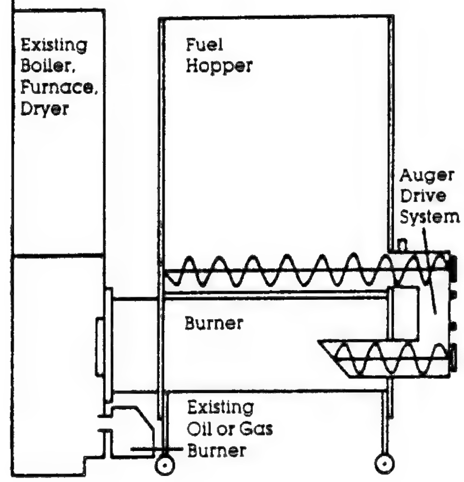
FIG. 7-1

Convenient

The TB 500 is an advanced solid fuel combustion system specifically designed for attaching to existing oil or gas fired furnaces, boilers, or dryers. In most applications the present burner is maintained for backup heat which is brought on automatically when the solid fuel supply is exhausted. Fuel is fed from an outside storage bin to the fuel hopper. From the hopper the fuel flows to the stainless steel burner where it is dried, gasified, then combusted. Ashes are removed within the burner so only the clean, hot gases enter the boiler or furnace.

- Automatic feed
- Automatic ignition
- Automatic switch to backup fuel
- Automatic ash removal
- High efficiency
- Low pollution, EPA tested
- Use present boiler, furnace, dryer
- Use present controls
- Long life
- Fast startup & shutdown
- 2-4 year payback
- Easy installation

TB 500
(Patent Pending)



Versatile

- Dry wood chips
- Green wood chips
- Wood pellets
- Wood cubes
- Nut shells
- Nut hulls
- Grass pellets
- Peat pellets
- Paper waste cubes

Specifications

Output
300,000-600,000 BTU/h max.
10:1 turndown ratio

Dimensions
4' long x 3' wide x 6' high

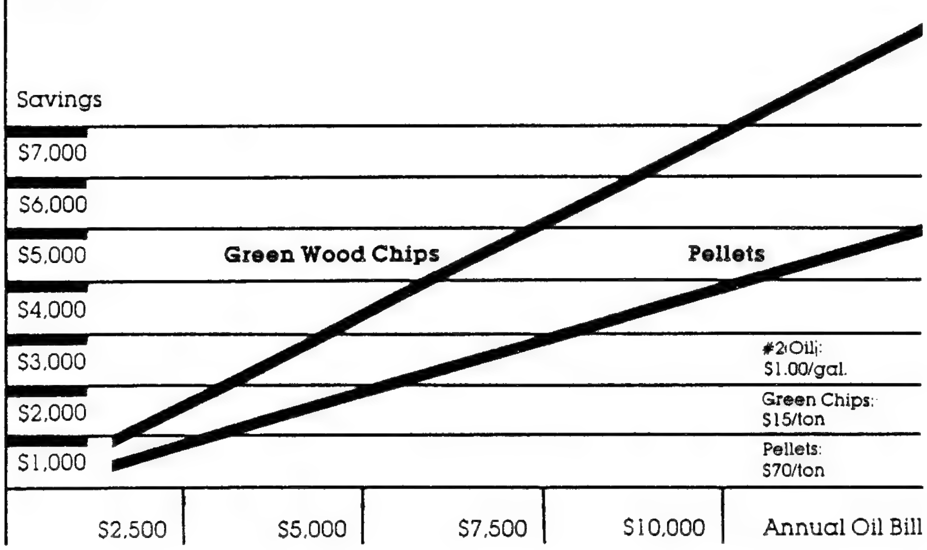
Weight
300 lb. (empty)

Electrical
110v, 20a

Safety
Timed burn-out
Split auger
Water sprinkler

Efficiency
Up to 88%, EPA tested

Economic



SOLID FUEL BURNER CONVERSION KIT

Heat Harvester Corporation
307 North Columbia Street
Chapel Hill, NC 27514
(919) 942-2007

FIG. 7-2

recommended for conversion (see Fig. 7-2). It is the only burner retrofit found that has automatic fuel feed and modulating fire control. The system costs less than 1/3 the price of boiler replacement. At the time of this publication Heat Harvester offered only one size (600-700 KBH).

All individual boilers which were not recommended for centralization and did not meet the above criteria were recommended for replacement by solid fuel boilers.

7.4 CANTONMENT AREA

7.4.1 Options Analyzed

7 solid fuel options were analyzed for the Cantonment Area. Vol. 1 Section 8.8

The first option analyzed the feasibility of centralizing the entire Area including replacement of the existing fuel oil and coal-fired boiler plants (BP 1 & 4) with a new solid fuel plant. The next four Options looked at various combinations of partial centralization. BP 1 and 4 were replaced in each case with successively smaller solid fuel plants and any individual boilers/furnaces not connected to the new distribution system were either retrofitted with new solid fuel burners or replaced entirely (see Table 7.2). The final 2 options took the 2 best cases from options 1 through 5 and looked at the feasibility of adding small solid fuel boilers to BP 1 to serve as the primary boilers with the existing fuel oil boilers serving as peaking boilers only.

Boiler sizing reflects the additional heat loss of the extended distribution system where applicable.

TABLE 7.2

ESTIMATED FUTURE FUEL CONSUMPTION FOR INDIVIDUAL BOILERS IN CANTONMENT AREA[(1)]

Bldg.	Future Fuel Use(MB/yr)	Existing Fuel	Bldg.	Future Fuel Use(MB/yr)	Existing Fuel
1	350	Oil	1201	450	Oil
26	740	Oil	1202	410	Coal
28	180	Propane	1203	450	Oil
29	180	Propane	1204	410	Coal
30	180	Propane	1208	410	Coal
51	360	Propane	1214	370	Oil
79	400	Propane	1217	1000	Oil
84	400	Oil	2069	220	Oil
170	180	Oil	2071	680	Oil
1010	930	Oil			
				8460	

(1) Based on present estimated consumption (see Volume 4, Building Data Sheets) and recommended energy conservation projects.

7.4.2 Emissions Compliance

Reference: Vol. 1 Section 8.7 & 8.8.1.4

Two forms of emissions exceeded the Lassen County Emission Control standards, particulate matter (PM) and sulfur oxides (SOX). Baghouses are recommended for PM control. SOX is exceeded only during very cold weather and can be controlled by burning a greater percentage of wood which contains no sulfur. In all cases, these two measures were able to keep SIAD within the emission standards.

7.4.3 Fuel Handling

Fuel was assumed to be a mixture of coal and wood chips (see Chpt. 5). Coal would be delivered twice a year by rail stored in a 1 year storage area near the railroad tracks, and transferred by truck and front end loader to the boiler plant 30-day storage area as needed.

Reference

Wood would be delivered by local suppliers as needed (14 trucks/month max. @ 25 Tons/load) and stored in a 30 day storage area near the boiler plant. Coal and wood would be delivered by SIAD personnel to the individual buildings which are not connected to the central steam distribution. Each building would have 7-day storage and automatic fuel handling (see Fig. 7-3 and 7-4).

7.4.4 Life Cycle Costs (LCC)

The seven options were analyzed on a life cycle cost basis. Capital cost for new equipment, operating and maintenance costs, and fuel costs to heat the entire Cantonment Area for the next 25 years were estimated for each option. — Vol. 1 Section 8.8.1 thru 8.8.7

The life cycle costs are based on the present worth analysis method. In other words the costs indicated are the amount that would have to be invested in FY 83 dollars to pay all system costs for the next 25 years.

Several assumptions are implicit in this analysis regarding the cost of money, fuel price inflation, operating and replacement costs, and labor rates. A complete listing of the assumptions can be found in the reference quoted at the right. — Vol. 1 Table 8.8

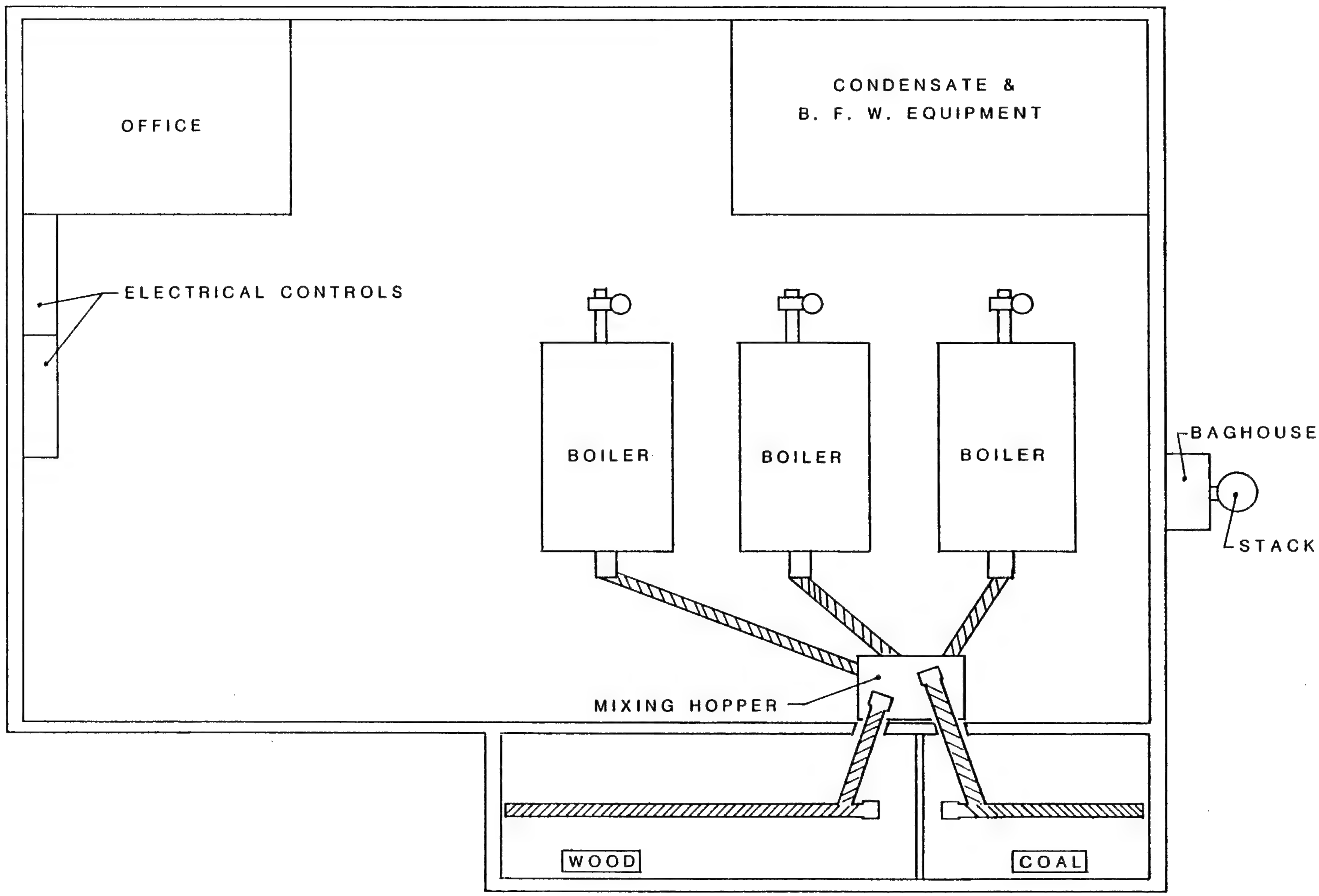
7.4.5 Conclusions

Option 1 displaces 100% of petroleum-based fuel in the Cantonment Area but has the highest LCC. Option 5A has the lowest LCC and displaces 50% of the petroleum-based fuel. The LCC of Option 4A is 2% higher than Option 5A, however 4A displaces 6% more petroleum-based fuel (see Table 7.3). — Vol. 1 Section 8.8.8

Fig. 7-5 indicates that the capital cost of the boiler plant and individual building modifications is the dominant factor in the life cycle costs. While fuel costs increase

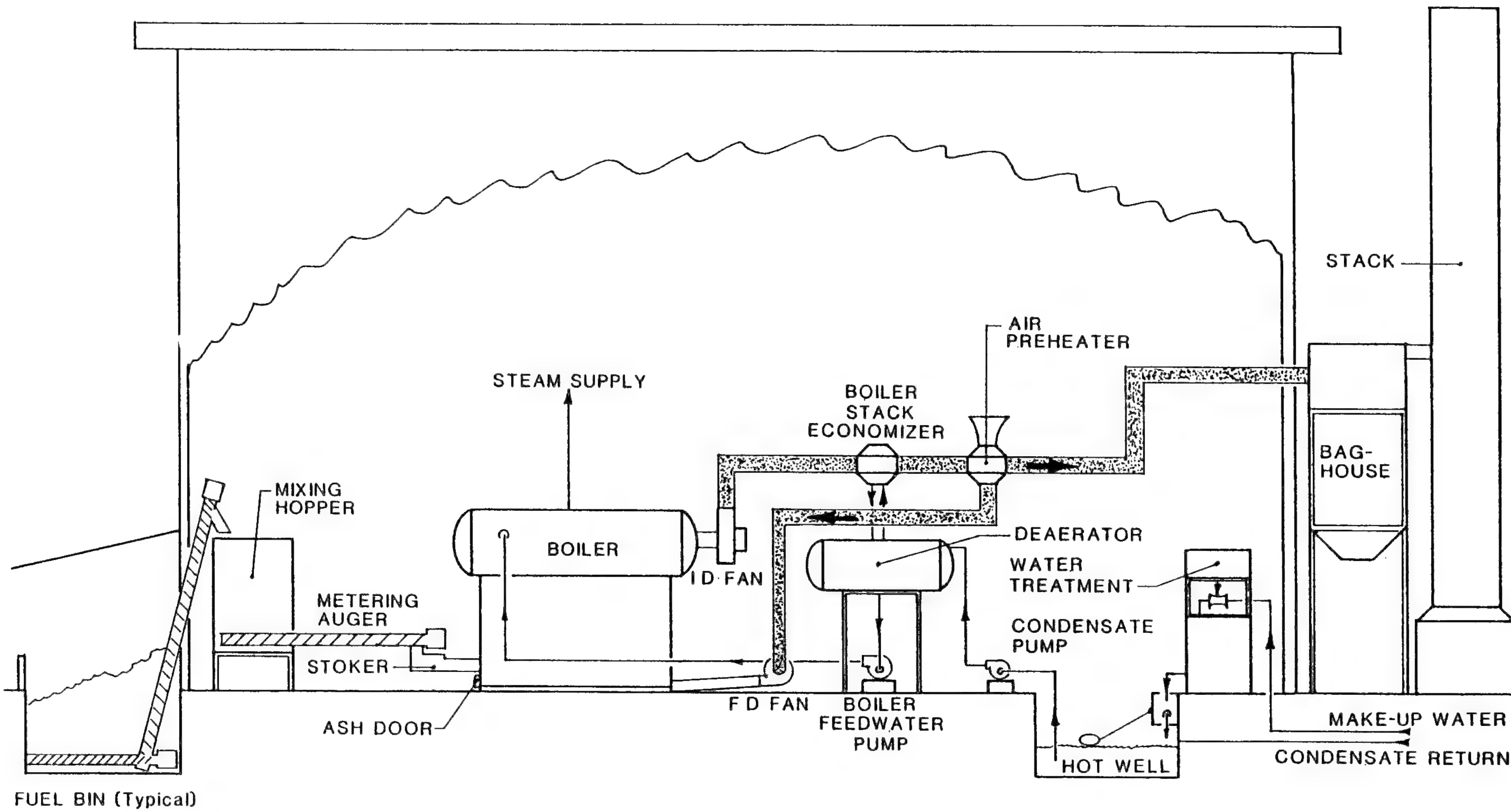
by 50% between Option 1 and Option 5 the savings in fuel cost is not enough to offset the capital cost.

The operating and maintenance (O&M) cost remained relatively constant from option to option. The labor savings from reducing the number of boilers (Option 1) is offset by the increased labor to properly maintain the steam distribution system.



SOLID FUEL HANDLING SCHEMATIC

FIG. 7-3



SOLID FUEL BOILER PLANT

FIG. 7-4

TABLE 7.3

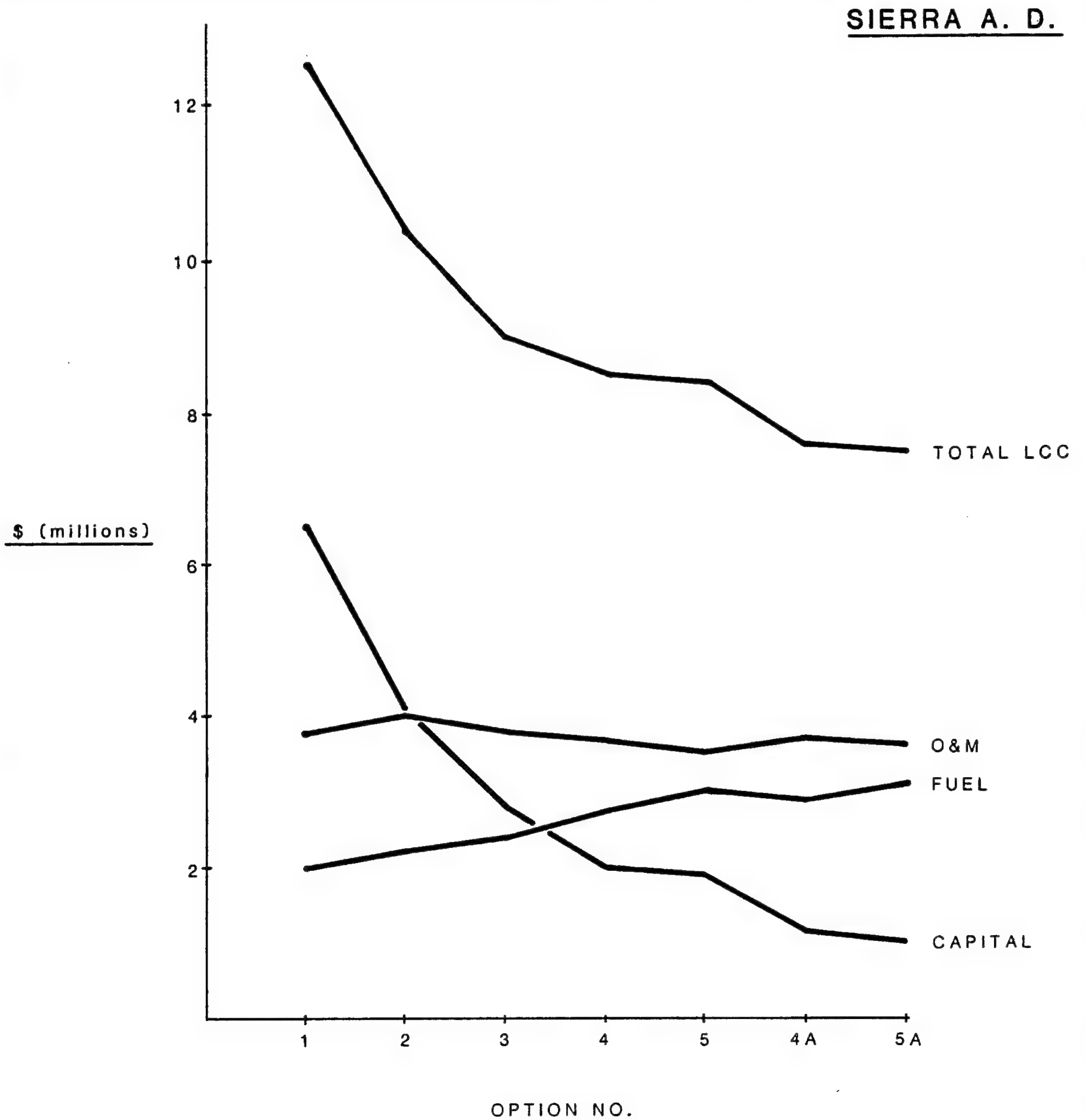
SUMMARY OF CENTRAL PLANT LIFE CYCLE COSTS - CANTONMENT AREA

	Option	Life Cycle Cost (K$)	Capital Cost (K$)	Maintenance Cost (K$)	Operating Cost (K$)	Total Fuel Cost (K$)	Solid Fuel Cost (K$)	Fossil Fuel Cost (K$)
1	New Solid Fuel Boiler Plant (2-600 & 1-400 HP boilers) to serve entire Cantonment Area.	12,457	6,554	2,006	1,847	2,050	2,050	0
2	New Solid Fuel boiler plant (2-400 & 1-250 HP boilers). Extend distribution to Bldgs. 1, 21-27, 176-195. Replace boilers in bldgs. 1201, 1203, 1214, 1217, 2071. Convert boilers in bldgs. 28, 29, 30, 51, 84, 170, 1010 to solid fuel	10,424	4,033	1,849	2,267	2,280	1,374	906
3	New Solid Fuel boiler plant (2-300 & 1-250 HP boilers). Replace boilers in bldgs. 26, 1201, 1203, 1214, 1217, 2071. Convert boilers in bldgs. 28, 29, 30 51, 84, 170, 1010 to solid fuel.	9,005	2,831	1,539	2,263	2,372	1,011	1,362
4	New Solid Fuel Plant(2-300HP & 1-250HP boilers). Convert boilers in bldgs. 28, 29, 30 51, 84, 170, 1010 to solid fuel.	8,457	1,969	1,539	2,209	2,740	881	1,859
5	New Solid Fuel Plant (2-300HP & 1-250HP boilers) serving existing distribution system	8,323	1,859	1,410	2,118	2,936	784	2,152

TABLE 7.3 (cont'd)

SUMMARY OF CENTRAL PLANT LIFE CYCLE COSTS - CANTONMENT AREA

	Option	Life Cycle Cost (K$)	Capital Cost (K$)	Maintenance Cost (K$)	Operating Cost (K$)	Total Fuel Cost (K$)	Solid Fuel Cost (K$)	Fossil Fuel Cost (K$)
4A	Add 1-250HP & 1-100HP Solid Fuel Boilers to BP-1. Use 3 existing 250HP oil fired boilers for peaking and backup. Convert boilers in bldgs. 28, 29, 30, 51, 84, 170, 1010 to solid fuel .	7,672	1,113	1,495	2,209	2,885	843	2,011
5A	Add 1-250HP & 1-100HP Solid Fuel Boilers to BP-1. Use 3 existing 250HP oil fired boilers for peaking and backup.	7,537	1,003	1,365	2,118	3,051	747	2,304



GRAPH OF CENTRAL PLANT LIFE CYCLE COSTS - CANTONMENT AREA

FIG. 7-5

Reference

7.5 SUPPLY AREA

7.5.1 Options Analyzed

Two options were analyzed for the Supply Area solid fuel boiler plant: Vol. 1 Section 8.9

Option 1: New boiler plant serving Supply Area.

Option 2: Addition of 1-250 HP solid fuel boiler to existing Boiler Plant 2. Use existing fuel oil fired boilers (2-250 and 1-125 HP) for peaking and backup.

No distribution system extensions were analyzed because the existing distribution system now provides 98% of the heat consumed in the Supply Area.

7.5.2 Conclusions & Recommendations For Supply Area

Table 7.4 summarizes the life cycle cost analyses for the two options considered. Option 2, add 1-250 HP solid fuel boiler and enclosure to existing BP-2, is recommended for the following reasons: Vol. 1 Section 8.9.3

- Lowest LCC
- Lowest capital investment
- New solid fuel boiler will displace more than 90% of the fuel oil requirements in the Supply Area.
- Existing fuel oil boilers in BP-2 are in good condition (estimated remaining life 25 years) and will provide excellent backup and peaking service.

It is also recommended that new instrumentation be installed for the existing boilers when this project is implemented.

TABLE 7.4

SUMMARY OF CENTRAL PLANT LIFE CYCLE COSTS - SUPPLY AREA

Option	Life Cycle Cost (K$)	Capital Cost (K$)	Maintenance Cost (K$)	Operating Cost (K$)	Total Fuel Cost (K$)	Solid Fuel Cost (K$)	Fossil Fuel Cost (K$)
1. New solid fuel plant (2-250 & 1-150 HP) to serve Supply Area	3,443	1,409	405	1,242	388	355	33
2. Add 1-250 HP solid fuel boiler and enclosure to BP-2. Use existing fuel oil boilers for peaking and backup.	2,538	466	332	1,242	498	320	178

7.6	REMAINDER OF POST	Reference

7.6.1 Description of Option

Based on the conclusions of the boiler plant analyses for Cantonment and Supply Areas only one option to the existing heating systems was analyzed for the 6 remaining areas on-post. This option includes: (Vol. 1 Section 8.10)

- 500 sq. ft. building addition to Boiler Plant 7 (BP-7) to house 1 new 100 HP solid fuel fired boiler.
- Convert existing boilers in buildings 401, 541, 544, 564 and 593 to solid fuel.
- Replace existing heating systems in buildings 403 and 640 with solid fuel boilers.

7.6.2 Design Load

BP-7, which serves Bldgs. 597 and 599, consumed 4,068 MB's ($49,825) in FY 81. The new 100 HP solid fuel boiler considered for this option will provide approximately 80% of the future projected annual consumption. (Vol. 1 Section 8.10.2)

The individual boilers in Bldgs. 401, 541, 544, 564 and 593 were chosen for conversion rather than replacement because each is estimated to have at least 20 years of useful life remaining and are in the size range for conversion from fuel oil to solid fuel. Each used at least 473 MB's ($4,630) of fuel oil in FY 81 and conglomerately used 3,200 MB's. After conversion each will use 100% solid fuel. Table 7.5 summarizes the estimated future energy consumption for each of the individual buildings.

7.6.3 Fuel Handling

The fuel handling system for BP-7 will be similar to the system described for Cantonment Area Option 1. Fuel handling for the individual systems will be scaled down versions of BP-7 depending on the size and fuel requirements for each. Bldg. 640 would have a fairly substantial system similar in size to BP-7 whereas those (Vol. 1 Section 8.10.3)

Reference

buildings which are just being converted will have only small storage and metering bins.

7.6.4 Building Heating Equipment Modification

The individual building modifications are summarized in Table 8.36 of Volume 1. Vol. 1 Table 8.36

TABLE 7.5

ESTIMATED FUTURE FUEL CONSUMPTION FOR INDIVIDUAL HEATING SYSTEMS IN OTHER AREAS (1)

Bldg.	Future Fuel Use (MB/yr)	Existing Fuel	Bldg.	Future Fuel Use (MB/yr)	Existing Fuel
401	480	Oil	564	370	Oil
403	1,310	Oil	593	1,040	Oil
541	680	Oil	634	230	Oil
544	450	Oil	640	1,790	Oil

(1) Based on present estimated consumption (see Volume 4, Building Data Sheets) and recommended energy conservation projects.

7.6.5 Conclusions & Recommendations

This option would reduce SIAD's fuel oil consumption approximately 12% (8,200 MB/yr) at a total life cycle cost of $2,122,000 (see Table 7.6). The individual building conversion/replacements could be accomplished one at a time or all together depending on available funds. Vol. 1 Section 8.10.6

Based on the options previously analyzed for the Cantonment and Supply Areas, the option analyzed here for the remaining areas of post represents the most reasonable method of converting to solid fuel and is therefore recommended for the existing boilers when this project is implemented.

TABLE 7.6

SUMMARY OF CENTRAL PLANT LIFE CYCLE COSTS - REMAINDER OF POST

Option	Life Cycle Cost (K$)	Capital Cost (K$)	Maintenance Cost (K$)	Operating Cost (K$)	Total Fuel Cost (K$)	Solid Fuel Cost (K$)	Fossil Fuel Cost (K$)
1. Retrofit BP-7 w/1-100 HP solid fuel boiler. Convert boilers in Bldgs. 401, 541, 544, 564 and 593 to solid fuel. Replace boilers in Bldg. 403 and 640 with solid fuel boilers.	2,122	838	357	556	371	284	87

Reference

7.7 SUMMARY OF CENTRAL PLANT RECOMMENDATIONS

The first three options listed in Table 7.7 will displace 37,500 MB/yr of fossil fuel (56% of the future heating requirements for the post) at a capital cost of $2,417,000 and a life cycle cost of $12,332,000. If this project is judged on the basis of economics with fossil fuel displacement being of secondary importance, these options offer the best return on investment. However, if fossil fuel displacement is the primary goal, with economics being of secondary importance, the second set of projects would displace 58,900 MB/yr of fossil fuel (87% of the future heating requirements for the post) at a capital cost of $8,800,000 and a life cycle cost of $18,022,000.

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Section 8.11

TABLE 7.7

SUMMARY OF CENTRAL PLANT RECOMMENDATIONS

Area	Description	Fossil Fuel Displacement (MB/yr)	Capital Cost ($ thousands)	25 Year Life Cycle Cost ($ thousands)
1. Maximum Return on Investment				
Cantonment	Option 4A - Retrofit BP 1 w/1-250 and 100 HP solid fuel boilers. Convert boilers in Bldgs. 28, 29 30, 51, 84, 170 and 1010 to solid fuel.	19,600	1,113	7,672
Supply	Option 2 - Retrofit BP 2 w/1-250 HP solid fuel boiler	9,700	466	2,538
Remainder of Post	Retrofit BP 7 w/1-100 HP solid fuel boiler. Convert boilers in Bldgs. 401,541,544,564 and 593 to solid fuel. Replace boilers in Bldgs. 403 and 640 with solid fuel boiler.	8,200	838	2,122
		37,500	2,417	12,332
2. Maximum Displacement of Fuel Oil				
Cantonment	Option 1 - new solid fuel plant w/2-600 and 1-400 HP boilers serving entire Cantonment Area.	39,900	6,554	12,457
Supply	Option 1 - New solid fuel plant w/2-250 and 1-150 HP boilers.	10,800	1,408	3,443
Remainder of Post	Retrofit BP 7 w/1-100 HP solid fuel boiler. Convert boilers in Bldgs. 401, 541, 544,564 and 593 to solid fuel. Replace boilers in Bldgs. 403 and 640 with solid fuel boiler.	8,200	838	2,122
		58,900	8,800	18,022

CHAPTER 8

BASEWIDE ENERGY MASTER PLAN

8.1 OVERVIEW

Reference

The purpose of the Energy Engineering Analysis Program (EEAP) is to aid SIAD's Commanding Officer in developing a Basewide Energy Master Plan in concert with the objectives of the Army Facilities Energy Plan published 1 October, 1978 and revised 26 Oct, 1981 by the Office of the Chief of Engineers. The EEAP addresses energy conservation in facilities and conversion to non-petroleum fuels. When combined with the Commanding Officer's plan for energy reduction in all other non-facility areas, i.e. transportation, it will provide the basis for the Basewide Energy Master Plan. This chapter presents a summary of the following:

Volume 1
Appendix 1

1. Army Facilities Energy Goals as outlined in the Army Facilities Energy Plan.
2. SIAD's present and projected future status with regard to the facilities and critical fuel portions of the Army Facilities Energy Goals.
3. Long-range plan for the implementation of each of the energy conservation and fuel conversion measures recommended in the EEAP.

8.2 ARMY FACILITIES ENERGY GOALS

The Army Facilities Energy Plan sets energy goals for FY 85 and FY 2000 for individual facilities. These goals have been edited to fit SIAD and are summarized below. A complete copy of the goals is included in the Appendix of Volume 1.

Volume 1
Appendix 1

Reference

8.2.1 Conservation Goals

A. Reduce baseline FY 1975 total facilities energy consumption (Btu) 20 percent by FY 1985 and 40 percent by FY 2000.

8.2.2 Strategic Fuels Goals

A. Develop the capability to use synthetic gases by FY 2000.

B. Reduce heating oil consumption by 75 percent by FY 2000.

8.3 SIAD STATUS REGARDING ENERGY CONSUMPTION

8.3.1 FY 85 Goals

SIAD's facilities energy usage during FY 75 was 250,000 MB's, thereby establishing the FY 85 goal at 200,000 MB's. We project that SIAD will use 218,400 MB's of energy in FY 85, falling short of the goal by 7.2%. Any energy conservation projects prior to FY 86 will have to be accomplished through funding other than ECIP because the recommended ECIP projects are currently scheduled for FY 86 funding with energy savings realized in FY 87.

Volume 1 Section 3.6

Volume 3 Section 2.1

8.3.2 FY 2000 Goals

Four projects for ECIP funding were identified in the EEAP (see Executive Summary, Chapter 3). These projects are projected to be FY86 contracts. In addition, several buildings are targeted for replacement in the Building Master Plan (see Table 3.10, Executive Summary) which will combine many activities

Volume 2

Volume 3 Table 2.6

Reference

presently in high energy consuming buildings into energy conserving buildings.

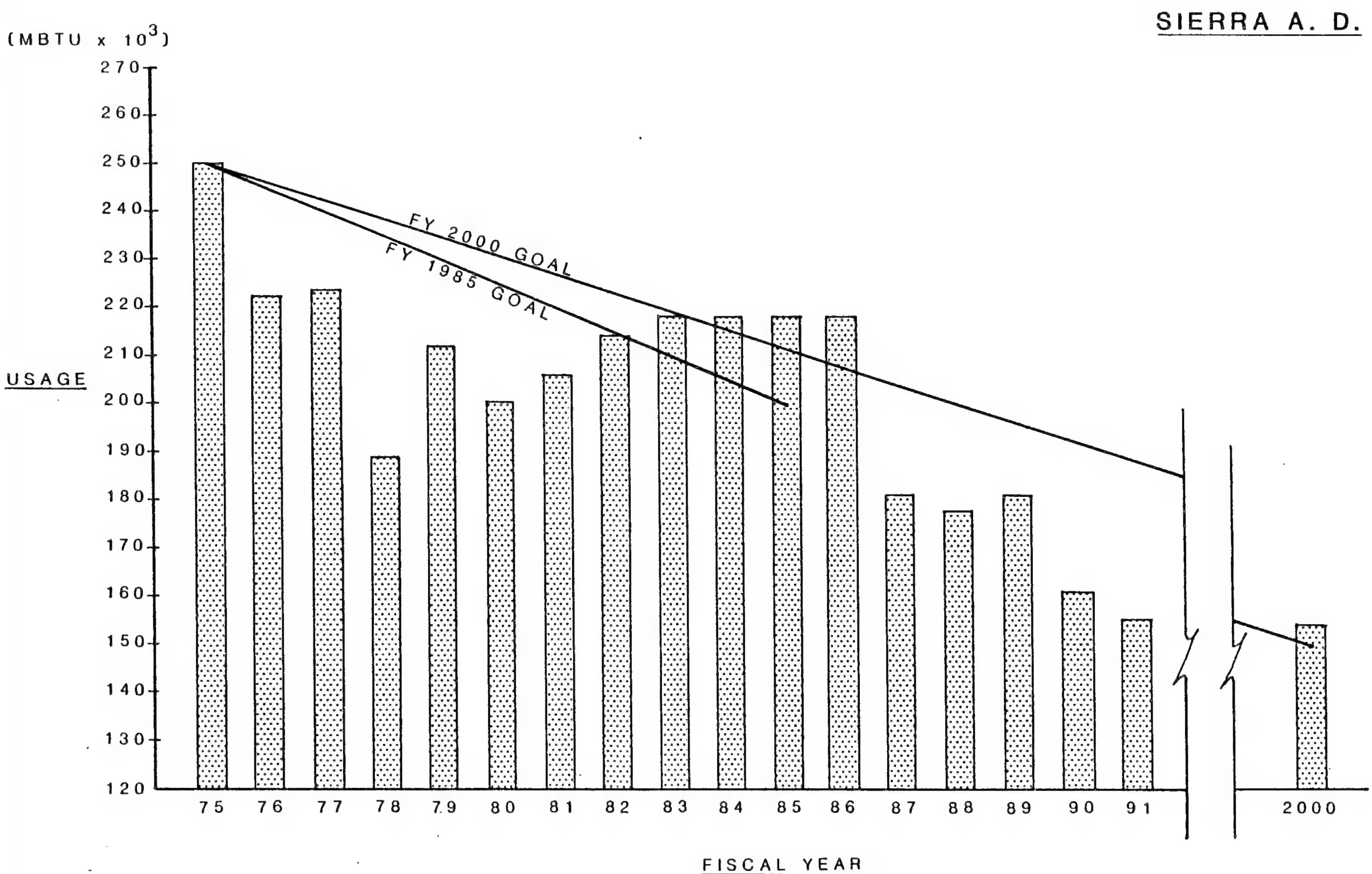
If all the energy conservation measures including the ECIP projects and the building replacements are completed by FY 2000, SIAD's energy usage will decrease to 154,900 MB's/yr which represents a 38% reduction in energy consumption (Army goal is 40%).

Fig. 8.1 plots SIAD's past and projected future energy usage with respect to the FY 85 and FY 2000 goals. Note the drastic drop in FY 87 due to the impact of ECIP projects.

8.4 SIAD STATUS REGARDING CRITICAL FUELS

8.4.1 FY 85 Goals

4% of SIAD's FY 81 total energy usage was coal. We believe this percentage could be increased above the Army's FY 85 goal of 10% by operating the boilers in BP 4 (coal-fired) longer in the spring and fall. Presently BP 4 is used only in the summer to provide steam to the hospital and the 980th Mess Hall. It is recommended that SIAD leave BP 4 on line and supplement with the 3-250 HP boilers in BP 1 which can be reset to supply 40 psig steam (now set at 90 psig) until the 40 psig steam is not adequate to meet the heating load. At that point BP 4 would be taken off line and the output pressure of the BP1 boilers increased to meet the load. This measure would decrease SIAD's petroleum fuel consumption as well as it's fuel bill. Volume 1 Figure 3-8



ENERGY USAGE (FY 75 - 91)

FIG. 8-1

8.4.2	FY 2000 Goals	Reference
	The EEAP concludes that two non-petroleum fuels, coal and wood chips (from local National Forests), are readily available to SIAD. Geothermal appears promising but is not a sure thing and requires Army investment for exploration.	Volume 1 Section 6.2, 6.4.4, & 6.3.5
	Ten different coal/wood conversion schemes were analyzed in the EEAP. Two options are recommended.	Volume 1 Section 8.8 thru 8.10

Option 1

Description: Add coal/wood fired boilers to existing boiler plants BP 1, 2 and 7 to serve systems in Cantonment, Supply and 599 Area; convert boilers/furnaces in 12 individual buildings to coal/wood; and replace boilers in 2 more individual buildings. (Reference: Volume 1 Section 8.11)

Results: 56% reduction in petroleum fuel
$12,332,000 life cycle cost to heat entire post.

Option 2

Description: Extend existing steam distribution system to serve all buildings in Cantonment from new coal/wood/oil fired boiler plant; new coal/wood/oil fired boiler plant to serve existing steam distribution system in Supply; add new coal/wood boiler to 599 Area; convert boilers/furnaces in 5 individual buildings and replace boiler in 2 other buildings.

Results: 86% reduction in petroleum fuel
$18,022,000 life cycle cost to heat entire post.

Option 1 is the most attractive investment (lowest life cycle cost) but at the same time displaces the least amount of petroleum fuel. Option 2 is the least attractive investment (highest life cycle cost) but displaces the most petroleum fuel.

At this point in time Option 2 is the only option which meets the Army goals of 75% reduction in petroleum fuel. However, we believe that in the near future more solid fuel conversion units will be developed which would increase Option 1 above the 75% goal. Replacing oil/propane burners with solid fuel burners, i.e. Heat Harvester tunnel burner is much less expensive than replacing an entire boiler or furnace. Therefore, it is reasonable to believe that individual plant and building conversion (Option 1) would be more cost effective with the added advantage of being able to convert as many or as few as available funds will permit.

We believe Option 1 is a better choice for the following reasons:

1. Life cycle cost will be less when equipment is developed.
2. Decentralization means less chance of total outage and significantly less energy consumption (no steam distribution piping between buildings).
3. Lower initial investment spread out over time.

8.5 IMPLEMENTATION PLAN

8.5.1 Schedule

Fig. 8-2 indicates the projected schedule for implementing the energy projects recommended in the EEAP. The schedule has been reviewed by SIAD's Facility Engineer, Mr. Andy Reiss, and his staff. It assumes receipt of funding for the 4 ECIP projects (EMCS, Weatherization, Lighting, and Air Compressors - see Chapter 3) in FY 86. It further assumes sufficient funds for the O&M projects (Increment F) to be completed in FY 84 through FY 87.

8.5.2 Costs & Manpower — Reference

All project costs include funds for design, supervision, overhead, profit and construction by private contractors. Therefore no additional manpower is required for any of the energy conservation construction.

The EMCS and solid fuel plant conversions will require additional maintenance staff. Since the EMCS is a one-way FM system used only for on-off control it requires a total of 1 manday per week for operating and maintenance (see Table A-5.1 and A-5.3, Appendix 5, Vol. 1). The new solid fuel conversions will require an additional 1.5 man-years per year to properly operate and maintain the systems including fuel handling. Therefore, the two new systems, EMCS and solid fuel heating plants, will require 2 additional maintenance personnel.

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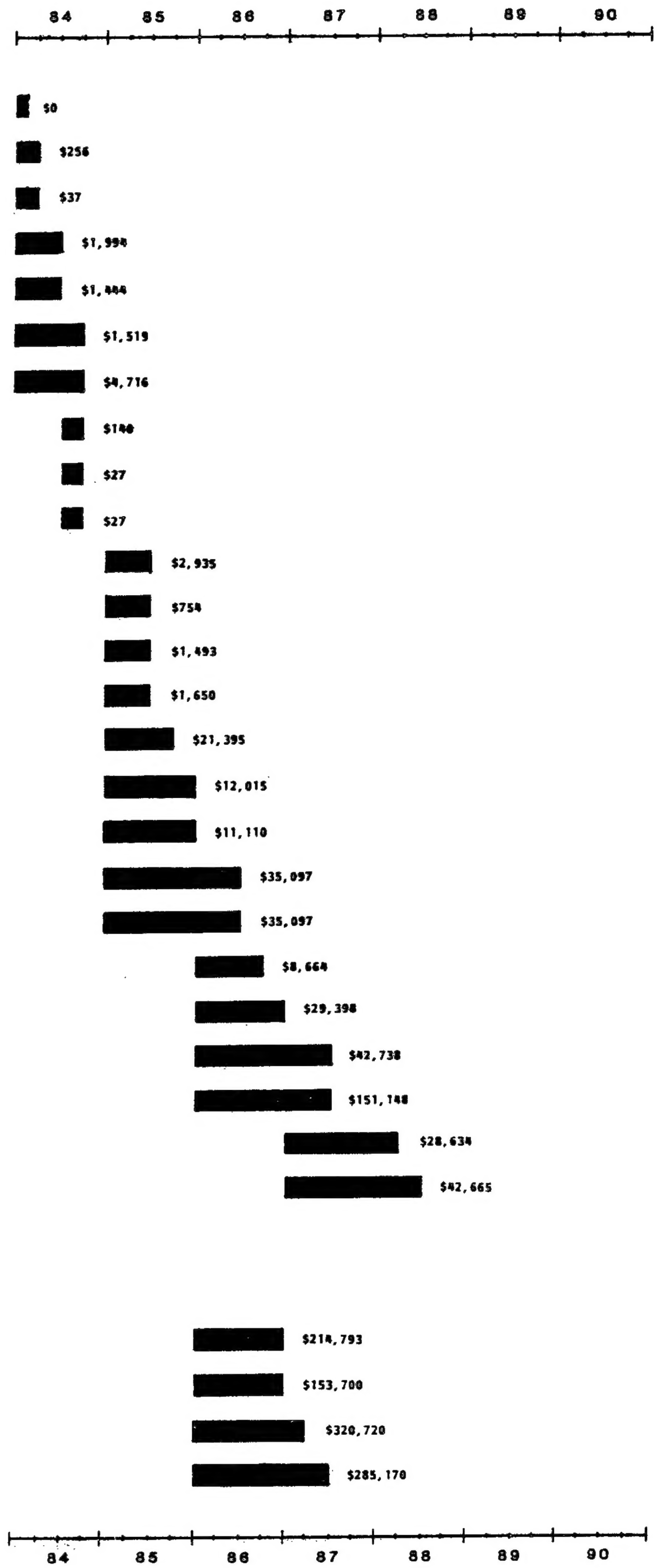
FIGURE 8-2

ENERGY CONSERVATION PROJECT SCHEDULE



PROJECT DESCRIPTION	FISCAL YEAR/COST
Increment F	
Instruct Occupants on Timeclock Operation-Bldg. 671	$0
Replace T-Stats-Bldg. 670 Vehicle Bays	$256
Controls Calibration-Relocate OSA Temp. Sensor Bldg. 671	$37
Repair Leaks-Various Buildings	$1,994
Lower DHW Temperature Various Bldgs.	$1,444
DHW Recirc. Pump Control Various Bldgs.	$1,519
Replace BFW Pump Controls Bldg. 54	$4,716
Shut Off Boiler in Summer Bldg. 100	$140
Raise Chilled Water & Cold Deck Setpoints Bldg. 150	$27
Controls Calibration-Raise CHW Temp Bldg. 672	$27
Insulate Piping & Equipment Various Bldgs.	$2,935
Manual Timer on Lights Various Bldgs.	$754
Interlock Condenser Controls to Chiller Bldg. 150	$1,493
Reduce Infiltration Bldg. 54	$1,650
DHW Flow Restrictors Various Bldgs.	$21,395
Separate Dissimilar Functions-Install Air Handler for Calibration-Bldg. 672	$12,015
Reclaim Condenser Heat Bldg. 60	$11,110
Boiler Stack Economizer Bldg. 54, BP1	$35,097
Boiler Stack Economizer Bldg. 202, BP2	$35,097
Separate Dissimilar Functions-Separate HVAC System-Bldg. 100	$8,664
Reduce North Glass Various Bldgs.	$29,398
Separate Air Handlers & VAV Retrofit Bldg. 150	$42,738
Replace Steam Line Supply Area	$151,148
DHW Tank Timeclocks Various Bldgs.	$28,634
Replace Electric DHW Tanks Various Bldgs.	$42,665
Increment A & B	
ECIP Project to Replace & Delamp Light Fixtures	$214,793
ECIP Project to Replace Air Compressors	$153,700
ECIP Project to Weatherize Various Bldgs.	$320,720
ECIP Project to Install EMCS	$285,170

Note: Project Costs in FY 83 dollars